United through a Common Geography

Statewide GIS Implementation Plan

SECOND EDITION

Texas Geographic Information Council

Revised November 1997

Austin, Texas

Preface

Updates to 1996 GIS Implementation Plan

The second edition of the Texas GIS Implementation Plan was first published in December 1996. The document was reprinted in November 1997, with very few changes to the content. This page lists significant changes in Texas GIS planning that have occurred between the first and second printings of the Second Edition.

The Texas Geographic Information Council (TGIC) was formed on September 1, 1997, through the merger of the Texas GIS Planning Council and the Texas Natural Resources Information System (TNRIS) Task Force. The goal of TGIC is to provide coordination and planning of statewide geospatial policies and strategies. Legislation in the General Appropriation Act, passed by the 75th Legislature, provides for the formation of TGIC. The Department of Information Resources and TNRIS will provide administrative support to TGIC. TGIC adopted an official charter and has 42 member agencies, universities, and statewide associations. TGIC has a Managers Committee that will support TGIC by providing technical advice, information, and research.

The Texas Orthoimagery Program (TOP) is completing the first phase of digital orthophoto (DOQ) production in east Texas and will continue into west Texas for statewide coverage. The Department of Information Resources received an Innovative Partnership award from USGS to complete the orthophotos. The USGS, Natural Resources Conservation Service, and Farm Service Agency are contributing federal funds. The second phase of TOP will be patterned after the first, with local/regional funds and funds from StratMap used for the state contribution. The first phase of TOP was for 4,850 digital ortho quarter-quads. The second phase will complete the balance of the DOQs needed for the state, outside of DOQs produced by USGS or USGS-sanctioned projects. The Texas Natural Resources Information System will place some resampled orthophotos (2.5, 10, and 30 meter resolutions) on the Internet for easier access.

The Strategic Mapping Initiative (StratMap) received funding from the State of Texas for the 1998–99 biennium. The General Appropriations Act provided state money for the creation of statewide digital data layers. The data include digital orthophotos, digital line graphs (hydrography, transportation, hypsography, boundaries), and soil surveys. StratMap is being coordinated by the Texas Water Development Board. StratMap is modeled after the Texas Orthoimagery Program with federal and local funding contributed to augment the state money.

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Executive Summary

This document, the *Statewide GIS Implementation Plan, Second Edition: United Through a Common Geography*, will serve as an agenda for the Texas GIS Planning Council interagency coordination of GIS and related technologies from publication date through the end of fiscal year 1999. Geographic Information Systems (GIS) are tools for management, analysis, and display of tremendous amounts of very important information. Because of this, they are uniquely suited to support decision-making for the highly complex issues that governments face every day. GIS is increasingly relied upon to support decision-making in all sectors of government and the economy.

This agenda is very similar to that presented in the first edition of the Implementation Plan, *Building Texas GIS Infrastructure*, published in 1994. The initiatives envisioned in that document; Partnership, Data Sharing, Base Map Development, and Field Data Collection continue to be the focus of these activities.

There are three objectives for FY 1998–99 activities related to the Partnership initiative:

1. Recertification of the Council as a cooperating partner with the Federal Geographic Data Committee (FGDC) in development of the National Spatial Data Infrastructure (NSDI),
2. Merger of the TNRIS Task Force and the GIS Planning Council, and
3. Development of a regional partnership program that includes formal recognition of regional GIS coordination efforts in Texas and supports the goals of NSDI.

Accomplishment of these objectives will build upon the accomplishments of the current biennia to ensure optimal organizational structures to support effective and efficient use of GIS and other geospatial technologies in Texas. The Partnership Resolution, passed in 1994, calls for the actions described in items one and three above, and the joint resolution of the Council and Task Force addresses item two. Thus no additional resolutions are needed to support these activities.

There are three objectives for FY 1998–99 activities related to the Network Data Sharing initiative:

1. Establishment and ongoing maintenance of an NSDI standards-compliant Internet accessible data server at TNRIS to provide access to all electronically available geospatial data in Texas, and to serve as a cornerstone for development of a network of NSDI standards-compliant data servers throughout the state,
2. Provision of all products of the Texas Orthoimagery Program and StratMap Initiative through this system, and
3. Development of a training and certification program that will provide a clear path for agencies or other entities seeking to use and/or supply data in this network.

There are three objectives for digital base map data development for FY 1998–99 in the Base Mapping initiative:

1. Complete the acquisition of 1:12,000 DOQs and 1:24,000 DEMs for Texas,
2. Provide a funding pool for the development of USGS digital line graph data layers such as transportation and hydrology, and
3. Where feasible, develop these products in partnership which allows local and regional entities to develop larger scale data layers.

In the 1994 Implementation Plan, digital ortho quarter-quads (DOQs) were one of the four main initiatives featured under the Base Map Development Resolution. Since this resolution, Texas has made great progress towards developing statewide DOQs. To follow up on this work, a program called StratMap will be initiated. StratMap will complete statewide DOQ and DEM acquisition, develop statewide vector digital line graph (DLG) coverage for selected DLG layers, and continue work on statewide soil data coverage.

There are four objectives for FY 1998–99 activities related to the Field Data Collection (GPS) initiative:

1. Completion of the first Beacon Transmitter Network of Texas site in Temple,
2. Increased coordination between Texas and the federal government regarding GPS expansion,
3. Further expansion of the BTNT to cover up to 90% of the state, and
4. Further development of GPS standards and guidelines for state agency users.

The major focus of the Field Data Collection initiative for FY 1998–99 will continue to be centered on creating a statewide real-time broadcast network for differential corrections. This network will be patterned after the U.S. Coast Guard's DGPS network, and every effort should be made to work with the federal government in creating the network. Until federal monies are made available to create additional beacon transmission sites in Texas, the state organizations, working in conjunction with the private sector, will pursue a variety of strategies aimed at creating the Beacon Transmitter Network of Texas (BTNT). After the first BTNT site is installed, the goal of the GPS Coordination Committee members leading this effort will be to implement 2 to 3 additional beacon sites in Texas during the 1998–99 biennium. These sites will be targeted for the West Texas area where there is currently no beacon coverage available.

The GIS Planning Council has enjoyed much success in carrying out the initiatives put forth in the first Implementation Plan. By all indications this success will continue over the next biennium. The credit for this resides in the agencies who participate. Without the voluntary participation of these agencies and the hard work of the individuals who represent them none of this success would have been possible.

1.0 Introduction

Geographic Information Systems (GIS) are tools that allow management, analysis, and display of tremendous amounts of very important information. Because of this, they are uniquely suited to support decision-making for the highly complex issues that governments face every day. GIS is increasingly relied upon to support decision-making in all sectors of government and the economy. Development and use of GIS demands carefully crafted organizational infrastructure and technological support. This Statewide GIS Implementation Plan (Plan) is designed to build such infrastructure and support, and to promote an environment in which Texas agency investments in GIS can be made in a efficient and effective manner and support quality decision-making throughout the state.

GIS is used at all levels of government in Texas. GIS enables many Texas agencies to access and maintain information that is essential for decision-making and service delivery. Cooperative GIS data development and data-sharing offers attractive paybacks in enhanced decision-making, improved service delivery, and leveraging of financial resources. Since data development accounts for approximately 80 percent of the cost of developing a GIS, coordinating data development and data sharing are high-impact, cost-effective ways to reduce costs. Recognizing the value of the technology and the need for interagency coordination, Texas agencies have committed significant time and energy to interagency coordination of GIS and related technologies through their voluntary participation in the Texas GIS Planning Council (Council). The Council was chartered for the purpose of coordinating implementation of this technology, in essence, to maximize the benefits and minimize the costs of state use of this technology.

This document, the *Statewide GIS Implementation Plan, Second Edition: United Through a Common Geography*, will serve as an agenda for Council inter-agency coordination of GIS and related technologies from publication date through the end of fiscal 1999. This agenda is very similar to that presented in the first edition of the Implementation Plan, *Building Texas GIS Infrastructure*. The initiatives envisioned in that document, with one minor change, continue to be the focus of these activities.

Building Texas GIS Infrastructure included four specific initiatives which are key to developing Texas GIS capabilities. The first initiative was the Partnership Initiative. In this, the Council expressed its desire to develop broader and more cooperative relations with other sectors of the government and the economy to build organizational relationships. The second initiative, the Network Data Access initiative, supported adoption of data documentation and transfer standards and use of the Internet to promote data sharing. The third initiative, the Base Mapping initiative, called for development of a consistent layer of digital imagery across the state. The fourth initiative, the Field Data Collection initiative, called for consistent implementation of field data collection technologies across the state.

Each initiative was authorized by a Council resolution. All resolutions and the original Implementation Plan were approved by the Council on November 22, 1994. In retrospect, these resolutions and initiatives were visionary and have led to tremendous success in a number of areas. A few examples of this success include:

- the Council was the *first* state coordinating body identified as a cooperating partner with the Federal Geographic Data Committee (FGDC)—its federal counterpart,
- receipt of multiple grants for piloting data exchange programs over the Internet, and
- receipt of several million dollars in grants and matching funds for Texas base map development.

1.1 Audience and Document Organization

The intended audience for this plan includes Texas GIS practitioners and decision-makers whose need to read this is based on how GIS technology can help them, their agencies, and most importantly the citizens of Texas. Technical material is available in the appendixes.
Each of the initiatives has a chapter and an appendix associated with it. The following table lists the chapters and appendices that relate to each initiative.

Organization of this Document

Initiative	*Chapter*	*Appendix*
Partnership	3	A
Network Data Access	4	B
Base Mapping	5	C
Global Positioning Systems	6	D

The organization of this document is very similar to the 1994 Implementation Plan. The models for all four initiatives are presented in Chapter 2 and then the following chapters, as indicated above, are dedicated to the initiatives. These chapters are all organized identically. A brief discussion of each initiative is followed by these key aspects:

- the 1994 resolution,
- review of federal and national trends,
- related technologies and opportunities (organizational structures and opportunities in the case of the Partnership Initiative),
- specific accomplishments since 1994,
- future plans, and
- benefits of future plans.

The title of this document, *United by a Common Geography*, was chosen to convey two meanings. In addition to living within a common physical geography, as a result, at least in part, of this Implementation Plan we hope to share the measures of that environment. Thus the fact that agencies will share a common geography (geo - world, and graphic - measures) will unite them as well.

One other point of introduction should be made. The Council is currently working with representatives of the Texas Natural Resources Information System (TNRIS) Task Force to develop a framework and time line for merger of the two organizations. Though this is addressed in the partnership discussions in Chapter 3, this process is not far enough along to warrant joint production of this implementation plan. It should be noted that the ultimate agenda for Texas coordination of GIS and geospatial technologies, over the period addressed by this document, will likely include other items brought forth by the TNRIS Task Force. It is expected that this merger will happen on or before September 1997. At that time, should it be warranted, a subsequent document may be published to augment this plan. It is expected that the third edition of the GIS Implementation Plan will be published by the merged committee, likely to be called the Texas Geospatial Information Council, in November 1998.

1.2 Authority and Vision

This document was developed on the authority of the Texas Geographic Information Systems Planning Council (Council), in fulfillment of its charter and the goal of *planning for the most cost effective means of acquiring and distributing geographic information to the state as a whole and ensuring that agency programs are in concert with other state, federal, and local programs*. In coordinating interagency policy and planning for use of GIS technology, the Council found it prudent to use the vehicle of a statewide GIS Implementation Plan in 1994. This is the updated version of that document.

In October 1992, the Council published the Geographic Information System Business Plan (Business Plan). The Business Plan described a framework for interagency data sharing in which geographic data layers are developed and maintained by agencies best suited to perform these functions (custodial agencies) and shared electronically with all other agencies needing the information. By describing an environment in which agencies use one another's data, this plan articulated a vision of interrelated cooperation between state agencies designed to enhance service capabilities while reducing costs to all participants.

1.3 Initiative Development

Development of the initiatives included in this Plan originally occurred through an interactive participatory process involving all Council member agencies and other interested parties during the fall of 1994. A survey was conducted to develop a profile of current GIS capabilities and coordination needs. The survey asked agencies to respond to questions regarding their application of GIS technologies and their needs for services. Representatives were asked to evaluate the potential value of each of twenty proposed program areas for GIS coordination. Each program area was rated, on a scale of "1" (not significant) through "5" (crucial, i.e., a top priority), according to the perceived potential impact of the program area on the agency's ability to meet its objectives and better serve the citizens of Texas. The results of this question are presented in the table below. The "Average Rating" column represent the average ratings for all responding agencies for each program area. The sequence of the "priority" column has been determined by sorting the "average rating" column.

Prioritized GIS Coordination Program Area Needs

Priority	*Program Area Needs*	*Average Rating*
1	Coordination with federal sector	4.40
2	Cooperative data development	3.75
3	Coordination with universities	3.70
4	Digital metadata/data layer clearinghouse	3.55
5	Coordination with local sector	3.45
6	Sponsor GIS workshops and conferences	3.30
7	Training in access/use of state GIS resources	3.20
8	Coordination with private sector	3.20
9	GIS resources/requirements manual	3.15
10	Cooperative purchasing arrangements	3.05
11	Coordination with other states	3.05

Scale
5 = Crucial (should be a top priority)
4 = Very significant (should be a priority)
3 = Significant (need should be addressed)
2 = Somewhat significant (nice to have)
1 = Not significant

All program areas listed in the table received average ratings above "3" (should be done), and one program area (coordination with federal sector) received an average rating higher than "4" (should be a priority). The results clearly demonstrate that "coordination with the federal sector" and "cooperative data development arrangements" are considered essential by most agencies. The initiatives described in this plan were designed to provide the organizational infrastructure and geospatial data necessary to support all the top priority agency concerns identified through this process.

1.4 Overview of GIS Applications in Texas

Data used by GIS systems can be organized by themes or layers. Each layer corresponds to a single type of geospatial phenomenon such as transportation (highways) or hydrology (water features). GIS systems combine different layers of information to produce new information layers. A transportation layer and a hydrology layer, for example, could be merged to produce a map displaying a new layer showing which highway sections are likely to be inundated during a particular flooding event. Virtually any spatially distributed phenomena (soil types, parcels, administrative boundaries, topography, rivers and streams, vegetation types, facility locations, wellspots, pipelines, or distribution of welfare recipients) can be stored, manipulated, and analyzed within a GIS.

A partial list of the current applications of GIS technology in Texas state government is included below. These applications illustrate the variety of ways GIS can be applied and the extent to which GIS technology is integrated into the decision support structure of selected Texas agencies.

Representative Current Uses of GIS in Texas

Aquatic Habitat Planning and Tracking
Abandoned Well Inventory
Abandoned Mine Inventory
Accounts and Records Tracking
Agricultural Crop Monitoring and Modeling
Aquifer Assessment
Aquifer Delineations
Archaeology Surveying
Bighorn Sheep Tracking
Census Data Analysis
Client Analysis (various agencies)
Client Profiles and Expenditures
Coastal Erosion
Coastal Fisheries Assessment
Coastal Rookeries
Coastal Waterways and Spoil Locations
Construction Project Tracking (various agencies)
Consumer Service Programs Database Management
Cost Analysis (various agencies)
Determination of Historical Land Use
Disaster Relief Assistance
Disease Mapping
Drastic Mapping (Pollution Potential Analysis)
Drought Planning
Electric Transmission Line Routing

Electrical Power Monitoring
Emission Inventory Quality Assurance
Emissions Inventory Records
Endangered Species Management
Environmental Compliance
Erodible Soils Tracking
Facilities Inspection Tracking
Facilities Management
Facilities Modeling and Analysis
Fire Safety Training
Flood Frequency Analysis and Modeling
GAP Analysis
Gas Utilities Coverage Areas
Ground Water Modeling
Ground Water Wellhead Protection Program
Highway Performance Monitoring
HMO & Health Coverage Areas
Identify Emission Sources and Track Complaints
Infrastructure Monitoring and Tracking
Land Use Analysis
Land Use Planning
Legislative District Delineation & Redistricting
Location of Public Water Supply
Location Tracking of Environmentally Sensitive Areas
Location Tracking of Environmentally Sensitive Species
Locations Appropriate for Artificial Reefs
Locations of Water Supply Well
Maintenance and Updating of Legal Plats
Master Planning (various agencies)
Master Planning of Water Infrastructure
Mitigation (various agencies)
Modeling of Future Water Demands and Needs
Oil & Gas Well Permitting and Tracking
Oil Spill Data Management
Oil Spill Response & Deployment
Oil Spill Response Management
Pavement Management
Pipelines Tracking and Permitting
Plotting Movements of Whales, Seals, etc.
Point Source Proximity Analysis
Policy Analysis for NAFTA
Population Analysis and Modeling
Public Education Districts
Public Education Resources
Public Facilities Management
Public Lands and Facilities
Regional Aquifer Recharge and Draft Monitoring
Saltwater Boat Ramp Locations and Usage
Saltwater Recreational Angler Harvest
Specific Environmental Projects
State Park Planning
Surface Nonpoint Pollution Analysis
Surface Water Modeling
Teaching
Technical Analysis of Insurance Claims
Texas Clean Rivers Program (Analysis)
Texas Lands Leasing Tracking and Permitting
Texas Lands Mineral Lease Information
Texas Lands Mineral Resources Tracking and Modeling
Timber Harvest Tracking and Permitting
Timber Tracking and Permitting
Tracking/Permitting of Municipal Solid Waste Facilities
Transportation Corridor Modeling
Transportation Zone Rate Analysis
Utility Service Area Delineation
Water Supply and Demand Tracking
Watershed Analysis
Wetland Resources Database
Wetland Resources Mitigation and Monitoring
Wind Power Location Information
Wind Resource Screening Analysis
Wind Resources Modeling

2.0 Conceptual Models

This chapter presents three models for developing Texas GIS infrastructure. These models present high-level summaries of what is currently seen as the optimal way to build organization, data sharing, and geospatial data infrastructure for the state. The remainder of this document builds upon the conceptual models presented here through clarifying the issues and then focusing on initiatives to achieve these ends.

This plan supports standardized approaches to geospatial data acquisition focusing on development of statewide initiatives for acquisition of digital orthophotography and development of a statewide real-time broadcast network for Global Positioning System (GPS) correctional information.

2.1 Organizational Partnership

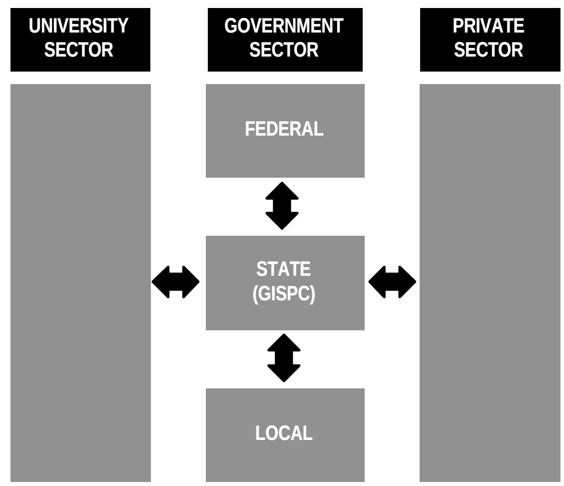
Geographic Information Systems technologies are in use at all levels of government, as well as within the private and university sectors. As digital spatial data is key to the development of a functional GIS, there is an abundance of digital information being developed (OMB estimated the federal government alone is spending $3 billion a year developing geospatial data). Although it is difficult to document, it is widely believed that the greatest amounts of money being spent on data development are at local and regional levels.

The challenge for developing an organizational infra-structure that supports GIS is in linking the people within these various sectors into a formal coordination network.

The GIS coordination network among Texas agencies is being facilitated through the GIS Planning Council (Council), see Appendix A.3. The interagency coordination effort, organized by the Council, involves all interested state agencies. This effort, organized to pro-vide executive, managerial, and technical level coordination of agency activities, has resulted in a robust GIS coordination program. The Council provides oversight and planning assistance for GIS coordination activities within Texas.

Exhibit 2.1 highlights four linkages that need to be developed to facilitate coordination of these various sectors of the economy. These linkages are:

- between state and federal agencies,
- between state and local/regional entities,
- between state and the private sector, and
- between state and the university sector.



Arrows represent partnership opportunities with other sectors of the economy

The Partnership Initiative presented in Chapter 3 describes a program that will build the organizational linkages needed to promote mutually supportive GIS programs between the various levels of government and the private sector. The organizational infrastructure that results will help increase efficiency, and reduce duplication in all sectors. The Partnership Initiative is key to the success of the other initiatives in this plan. Only through mutual agreement to work together can the state hope to harness the power of the numerous technological advances in this area for the benefit of the citizens and the state.

2.2 Network Data Sharing

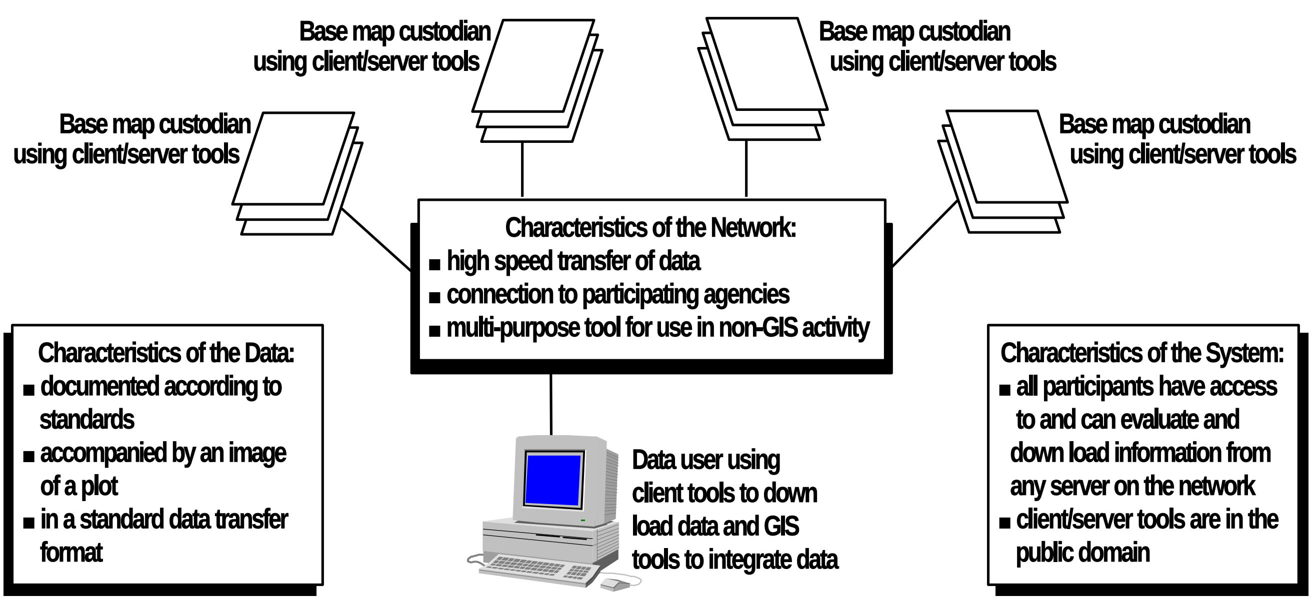
The reasons for developing data-sharing capabilities are straightforward and compelling. Work duplication can be avoided, data layers can be accessed quickly over a network, the best data is used, data standardization is done by experts, users need create only that data not already available, and users who become data suppliers contribute to the overall data inventory. Data sharing relies on specific technologies. These are introduced below and described in greater detail in Chapter 4.

As state agencies become more information-driven, networking technologies become more important. Computers are accommodating more users, auto-mated processes are becoming more sophisticated, and the volume and complexity of the information being developed, maintained and shared is increasing rapidly. Networking technologies reduce costs of services, enhance capability and capacity to provide services to businesses and citizens, provide more information choices and sources, support sharing of information such as GIS data files, and facilitate the provision of efficient, cost-effective services to local and regional governmental and educational entities.

Evolution of networking technology, increased connectivity of state agencies, and development of federal standards for GIS data transfer have stimulated GIS data-sharing among agencies. The Federal Geographic Data Committee (FGDC) continues to lead the effort to enhance data-sharing capabilities. The FGDC is promoting the development of the National Spatial Data Infrastructure (NSDI), which will support development of the organizational relationships, technological tools for data transfer, and geospatial data that comprise the GIS resources of the nation. The federal government has helped provide basic standards mechanisms for GIS data exchange and documentation. Information technology vendors and local and state government have built upon these ideas and are providing tools for spatial data management.

Texas has studied statewide spatial data management conceptually and strategically since 1990. Today, use of the technology pioneered by FGDC is central to the efforts of Texas state government to implement its data sharing vision. Using the national standards will also allow the state to tap into the best geospatial information resources developed and maintained at the federal level. Through partnership initiatives, these standards can be propagated at local and regional levels and within the private and university sectors. The result of this effort to build a data-sharing environment will be to provide agencies with the capability to electronically search for and transfer GIS data from a broad cross section of public and private state, national, regional, and local entities.

Exhibit 2.2 shows how data layers developed and maintained by individual agencies can be shared over an electronic network. The hypothetical users in this example need not develop any data themselves, but can instead take advantage of the work performed by the data providers.



2.3 Base Map Development

The optimal way to meet the need for accurate, compatible, digital maps is for the state to build and maintain a program to actively acquire data layers that are commonly needed by most or all agencies. This will help avoid the cost of each entity developing this data separately. A program called StratMap, designed to develop this *base map* information through cost-sharing partnership, is proposed in Chapter 5. The individual base map data layers proposed for inclusion in StratMap are listed below. The objective of StratMap is to provide 100% coverage of Texas with these data layers (with the exception of the soil surveys) by the end of fiscal 2001.

Where feasible, through cooperation of local and regional entities, the scale of these products may be better than those listed.

StratMap Base Map Data Layers

Digital Orthophoto Quarter-quads (DOQs) 1:12,000
Digital Line Graph 1:24,000 Transportation
Digital Line Graph 1:24,000 Political Boundaries
Digital Line Graph 1:24,000 Hydrography (water) layer
Digital Line Graph 1:24,000 Hypsography (elevation contours)
Digital Line Graph 1:24,000 Public Land Survey (Original Land Survey - cadastral data)
Digital Line Graph 1:24,000 Survey and Marker Control
Soil Survey 1:24,000 SSURGO *
Digital Elevation Models 1:24,000
* 70% coverage by FY 2001.

Exhibit 2.3 Base Map Development Model Not Available

Digital ortho quarter-quads (DOQs) are one of the data layers needed by most governmental agencies. These up-to-date, rectified, georeferenced photo images can provide control to produce and/or update both raster and vector thematic data layers. Though the production DOQs can take 6 to 8 months, the resulting product is much more up-to-date than most existing databases. Most of the USGS 7.5 minute Quadrangle maps for Texas, for example, are between 20 and 45 years old.

The USGS has an active program to develop 1:24,000 digital line graphs (DLGs) from the 1:24,000 analog topographic map series. In addition, the Natural Resources Conservation Commission is mapping soils at 1:24,000 scale. Unfortunately, given the level of federal funding, very little of Texas has been mapped digitally (see Exhibits C.1 through C.8 to see the status of USGS DLGs, DEMs, DOQs, and soils for Texas). Further, the digital products are created without updating the existing analog maps. This is problematic as some of these source maps are more than forty-five years old.

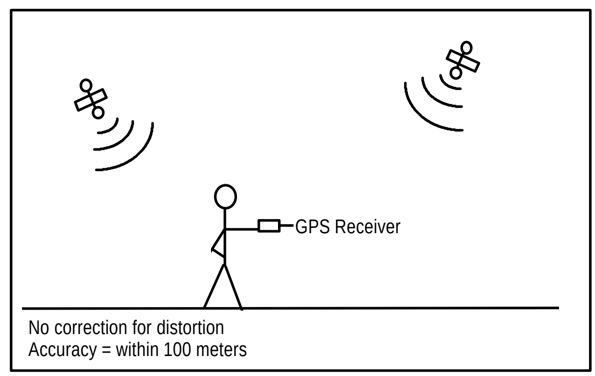
To complete Texas DOQ production and accelerate the development of up-to-date digital vector maps for Texas, the Texas GIS Planning Council has initiated the Strat-Map proposal. Exhibit 2.3 illustrates how these data layers will overlay on another for any given part of the state. Compatibility between the multiple base map data layers will facilitate information-sharing among agencies.

2.4 Field Data Collection

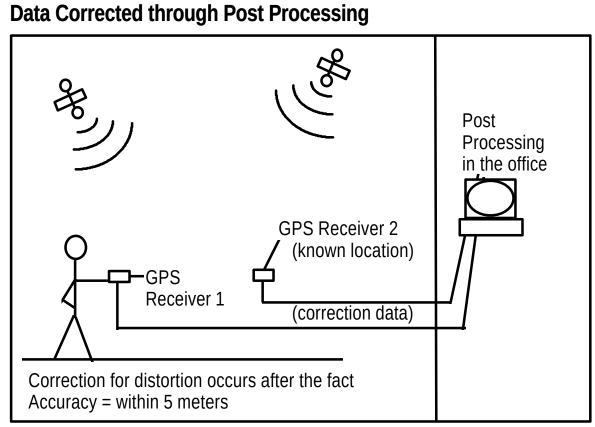
Agencies also need tools to capture geospatial information in the field. State agencies require accurate locational information on regulated facilities, on biological resources, environmentally sensitive areas, endangered species, and state-owned lands and facilities to carry out their duties. The traditional method for capturing this data is to send field teams out with various types of maps to try and determine where these things are, or to send survey teams out to identify these locations. Both of these methods are costly and time consuming and can result in varying levels of accuracy.

Agencies are now adopting a more reliable method of data capture by using the Global Positioning System (GPS). This satellite-based technology was developed during the 1980s by the Department of Defense (DoD), and is now being used by many federal and state agencies and the public. GPS technology is being used by many governmental agencies and throughout the private sector to capture accurate field data for inclusion in GIS databases. The use of this system needs to be expanded, and steps need to be taken to make the technology easier for agencies to adopt. The use of GPS technology as a data collection tool will allow agencies to collect data based on a common coordinate system that will ensure a highly standardized, reliable set of field data.

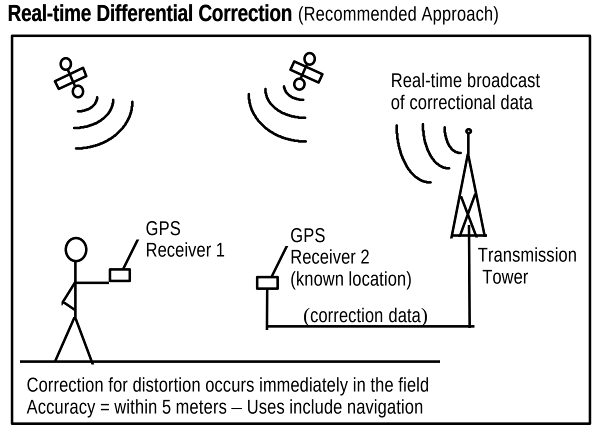
Uncorrected Data



Data Corrected through Post Processing



Real-time Differential Correction (Recommended Approach)



GPS technology utilizes hand-held receivers to interpret satellite signals and calculate a latitude/longitude location on the ground. The locational accuracy of “raw” GPS data ranges from 30 to 100 meters. This coordinate data can be corrected by a variety of methods to sharpen the accuracy to 2 meters or better. The GIS Planning Council supports a standards-based implementation of GPS technology which utilizes a correction method known as “real-time broadcast of differential correction information.” Development of a real-time broadcast network will aid in correcting GPS data in the field and ensure that the most cost-effective use of this technology is possible by all state and local government agencies.

The model for this initiative is illustrated in Exhibit 2.4. Note that the three approaches to GPS field data collection vary in terms of horizontal accuracy of information received, uses for the tool, and timing for availability of results. The third approach—real-time differential correction—is the approach advocated in this Plan. This approach provides the best information in the quickest manner and supports the most cost-effective use of the technology. Adopting this approach will allow the state to take advantage of the significant expertise within the Texas Department of Transporta-tion and other state agencies. This approach will enable the GPS data captured by one agency to be used by others and link the state into a nationwide program advocated by the U.S. Department of Transportation.

Once a network for real-time broadcast of GPS correctional data is established, the benefits of the system will be available in the public domain. This means that not only will government entities at all levels in the state be able to use it, but also private sector applications, some of which have the potential for significant job growth, can be built around these capabilities.

3.0 Partnership Initiative

The evolution of digital technologies of all types has broad ranging effects on many aspects of personal and professional life. In few areas are these changes as pronounced as they are in the area of government and mapping. The new landscape that is emerging presents a great number of opportunities for improving the efficiency and effectiveness of government. To take advantage of these opportunities, it is necessary to develop new sets of relationships that bring together policy-makers and technically talented individuals from the diverse cross section of entities with common interests in these fields. The formation of partnerships between these entities is fundamental for taking full advantage of new technologies. These partnerships are the foundation for coordination, data sharing, and cost sharing for data development. The achievements of the Texas GIS Planning Council (Council) over the past two years have demonstrated the high value of these partnerships in dealing with the complex policy and technological issues now facing the state.

This chapter describes a proposed set of relationships between the Council's interagency coordination efforts and entities of the federal government, regional, and local governments, universities, and the private sector. The partnership initiative is designed to extend the functional capabilities of state agencies by developing mutually supportive relationships with these entities. Through common adoption of standards, and common investment in data and systems that are of mutual value, these partnerships will support effective and efficient data sharing, base mapping, and Global Positioning Systems coordination (discussed in Chapters 4, 5, 6).

A significant amount of reference material has been made available for this chapter in Appendix A. In general, this material covers the history of statewide mapping and GIS coordination efforts in Texas. It also includes detailed information on the structure of the Council, and the Federal Geographic Data Committee (FGDC).

3.1 The 1994 Partnership Resolution

The Council seeks to develop a robust, productive GIS environment by working in cooperation with other entities at national, state, regional, and local levels to reach common goals related to the efficient acquisition and sharing of digital mapping information. There are several reasons for developing this type of cooperative/ collaborative environment. The cost of digital base map data development is one of the most compelling. Data development costs often preclude individual agencies from developing their own digital data. However, the transferability of this data, once in digital form, can greatly reduce the per-agency costs and help avoid duplication of effort associated with redigitizing data. Agencies that work together through partnerships to develop such products acquire a common frame of reference. Benefits of this extend beyond cost saving into the realm of improved alignment of function, and greater effectiveness.

Exhibit 3.1 contains the resolution passed by the Council in November 1994. This resolution has served well in meeting the Council's needs during the current biennium, and will continue to be the basis for the partnership initiative during the FY 1998–99 biennium.

Exhibit 3.2 provides a graphical overview of how the Council partnership initiative is designed to facilitate communication between different sectors.

3.2 National and International Trends

3.2.1 The Federal Geographic Data Committee

The FGDC, an interagency coordinating committee working at the federal level, was created through the Federal Office of Management and Budget (OMB) in Circular A-16 to reduce duplication of effort between federal agencies in their development of GIS and geospatial data.

The following federal agencies participate in FGDC:
Department of Agriculture
Department of Commerce
Department of Defense
Department of Energy
Department of Housing and Urban Development
Department of the Interior
Department of State
Department of Transportation
Environmental Protection Agency
Federal Emergency Management Agency
Library of Congress
National Aeronautics and Space Administration
National Archives and Records Administration
Tennessee Valley Authority

The FGDC is currently chaired by the Honorable Bruce Babbitt, Secretary of the Interior. Staff support for FGDC is provided through the U.S. Geological Survey. In addition to federal agencies, there is significant participation by private and non-profit sectors in FGDC.

FGDC has been soliciting participation of states in developing the National Spatial Data Infrastructure (NSDI), which will support development of the organi-zational structure, tools for data transfer, and geospatial data that comprise the GIS resources of the nation. NSDI is one of the National Information Infrastructure (NII) initiativesadvocated by the White House. On April 11, 1994, President Clinton signed Executive Order #12906, Coordinating Geographic Data Acquisition and Access (Appendix A.3).

The President's Executive Order directs the FGDC to coordinate the federal government's development of the NSDI (see Appendix A.5). It specifically calls for agencies to:

- contribute to a national geospatial data clearing-house and use the clearinghouse to determine data availability prior to starting a new data collection project;
- document data sets according to metadata standards, and to support public access to data;
- cooperatively develop data content standards and other geospatial data standards as necessary;
- develop a plan for initial implementation of, and ongoing maintenance for, a national digital geospatial data framework; and
- develop strategies to maximize cooperative efforts with state and local governments, the private sector, and other non-federal organizations to share costs and improve efficient acquisition of geospatial data consistent with the order.

WHEREAS, as executives of state agencies participating in the use, management, and analysis of human and natural resource data for the state of Texas, we recognize the importance of GIS technology and the value of geospatial data resources for support of decision making and in provision of quality service; and

WHEREAS, the Federal Government, through the Federal Geographic Data Committee, has been charged by executive order of the President to build relationships with states in support of developing the National Spatial Data Infrastructure; and

WHEREAS, the Regional Councils of Government in Texas, duly authorized organizations with conterminous coverage of the state, have expressed a willingness to coordinate matters of geospatial data infrastructure regionally for the Planning Council and federal entities; and

WHEREAS, opportunities exist for cost-sharing mechanism between the state and the federal and regional sectors; and

WHEREAS, coordination between the state and the federal and regional sectors can help avoid duplicate and wasteful development of geospatial data systems; and

WHEREAS, technologies are available to allow widely separated entities to share geospatial information quickly; and

WHEREAS, we, the Geographic Information Systems Planning Council, having been duly authorized by Department of Information Resources Charter and directed by executive order of the Governor, have produced plans for coordination and implementation of GIS technologies statewide that rely on good working relationships with other sectors of government;

NOW THEREFORE, we resolve, within budgetary limitations, to build partnerships and formal structures for coordinating the use of Geographic Information Systems and development of geospatial data with the federal government, through the auspices of the Federal Geographic Data Committee, and with regional and local entities through the auspices of Regional Councils of Government in Texas.

FGDC continues to support building a cooperative environment for sharing geospatial data electronically. Texas agencies have secured multiple grants from FGDC participants over the past two years. These include grants to TNRIS, the Lower Colorado River Authority, the General Land Office, and the North Central Texas GIS Consortium.

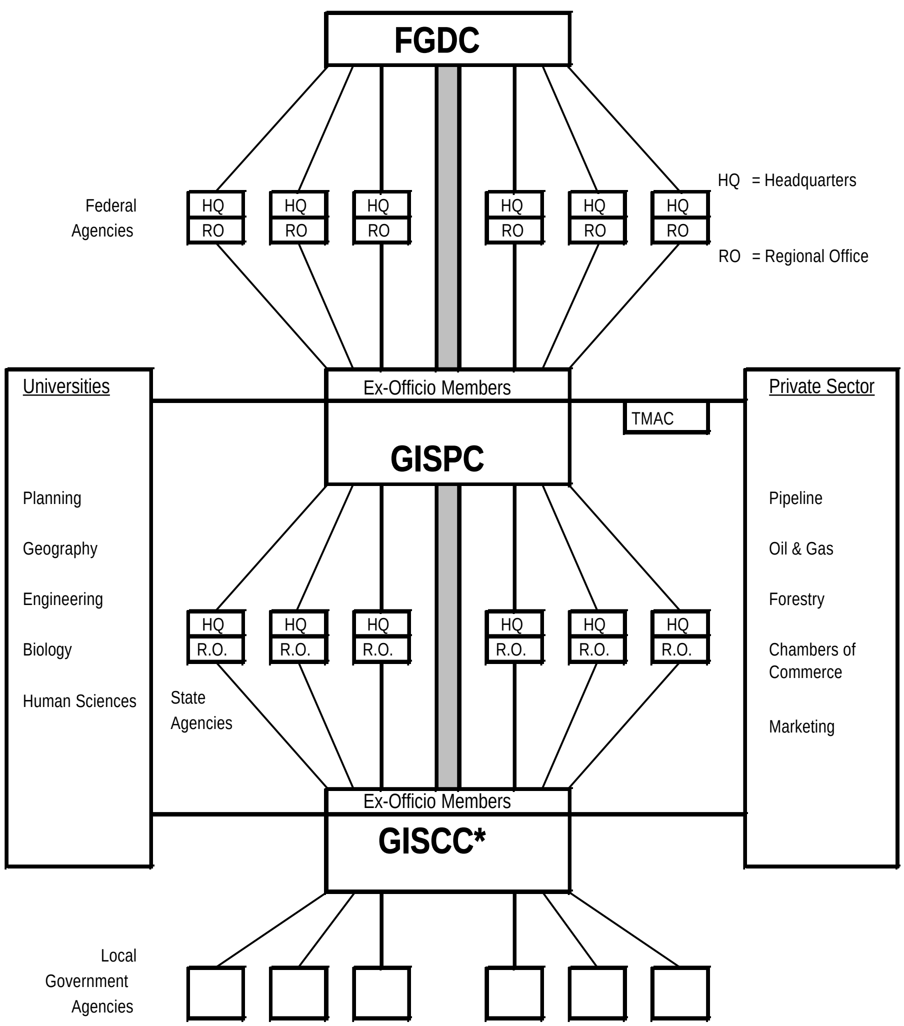
3.2.2 Transboundary Resource Inventory Project

The Texas-Mexico border is 900 miles long, involves two federal and five state governments, and is currently experiencing rapid population and industrial growth. Population of the Texas-Mexico border area grew at least 25 percent between 1980 and 1990 (to more than 3 million). Electric power generation, metallurgy, manufacturing and mining have increased with this growth. International trade, subject to trends on both sides of the border, strongly effects most sectors of the region's economy. Transboundary growth and development have greatly stressed existing infrastructure and environmental quality. Population and international commerce are expected to increase further in the wake of the North American Free Trade Agreement (NAFTA).

An inventory of consistent data regarding these natural resources and potential or existing impacts of human activities on them is needed by multiple state, federal, local, and private entities. Further data collection needs require identification and initiation of appropriate actions to meet these needs. TRIP is a single effort for developing databases which are accessible to all, avoid duplicate efforts, and promote free exchange of information, cost-sharing, and standard common terminology and software on both sides of the border.

Frequently, natural resources in the United States are influenced by, or connected to, counterparts in Mexico. Some data pertaining to natural resources in Mexico is unavailable or nonexistent. For these reasons, it is important to build an infrastructure that promotes building and sharing data on both sides of the border.

Many of the mandated land management activities of federal and state agencies along the Texas-Mexico border require mapping and analysis of information from both sides of the border. Economic, environmental and social programs rely on basic, comprehensive information about lands and natural resources. Systematic and consistent data pertaining to natural resources, transportation networks, population, and human impacts on both sides of the international border is largely absent. The incompleteness and incompatibility of existing sets of data hinders development and conservation of resources and monitoring or mitigation of crises associated with rapid growth.



The Transboundary Resource Inventory Program (TRIP) is a binational effort to promote the inventory, mapping, and efficient use of the natural resources shared between the United States and Mexico over an area roughly 100 miles wide along each side of the international border. It is a consortium of border institutions dedicated to the sharing data that describes the border region. Exhibit 3.3 lists the basic objectives of TRIP.

Digital Base Map—To encourage the United States Geological Survey and the Instituto Nacional de Estadistica, Geografia e Informatica in Mexico to cooperate in an aerial photography initiative to create a consistent digital base map of both sides of the border for use in a binational border-wide geographic information System.

Transboundary Data Layers— To determine the need for and facilitate the development of transboundary geospatial data layers to overlay onto a digital base map through a joint U.S.-Mexico GIS.

Border GIS on the Internet—To integrate new and existing publicly available data layers into a Transboundary Resource Information Management System (TRIMS), which will bring geospatial data into a border-wide GIS that allows the custodians of data to link their data together through the Internet (TNRIS' Border Information Center will be the principle node for distribution of data covering the Texas-Mexico extent of the border region.)

Forum for Discussion— To provide a forum for geographic information providers and users to communicate data needs of the border region and interact with policy makers and program managers.

Training and Technology Transfer—To facilitate the implementation of GIS in border institutions through training assistance and technology transfer, and to assist in building the capacity of state and local agencies, universities, and NGOs to use GIS as a management and communication tool.

The data sharing and data development plans for TRIP parallel the initiatives being put forth in this plan. A primary objective of TRIP is to locate or develop, and provide common access to spatial databases for hydrocarbon and mineral resources, aquifers, wind and solar power sites, biological resources, air and water quality, geology and hydrology, and other resources in the border region. This will provide government, industry, and the general public with access to data needed for maximizing economic growth while protecting environmental resources and human safety.

TRIP began in 1993 as an initiative of the Texas General Land office and the University of Texas at El Paso. Participation includes representatives from universities and governmental entities from the states of Texas, New Mexico, Arizona, and California, as well as from counterpart organizations in Mexico. A U.S. TRIP Board of Directors was formed in December 1995, and a counterpart board for TRIP Mexico was formed in late 1996. The two groups meet together quarterly. Administrative support for TRIP is provided by the Texas General Land Office. Current TRIP information is available through the TRIP home page: http://www.glo.state.tx.us/infosys/gis/trip

While TRIP is not a funding institution, it serves as a liaison with governmental and other potential funders to promote or facilitate natural resource projects in the border region. For example, TRIP played an influential role in supporting negotiations between the U.S. and Mexican governments for the acquisition of aerial photography which will serve as a basis for future mapping along both sides of the border.

3.3 Specific Accomplishments Since 1994

3.3.1 FGDC Recognition

Based on the Partnership initiative and the other initiatives put forth in the 1994 Implementation Plan, the Council received formal Recognition by the FGDC on January 20, 1995. Texas was the first state to receive this status.

In developing the partnerships that can help the state better implement GIS and related technologies, the first step was for the Council to solicit and receive formal recognition of its statewide coordination role by the FGDC. This was achieved during the FY 1996–97 biennium. Increased involvement with FGDC through this program has:

- strengthened Texas influence on federal priorities for data development;
- provided means for funding GIS coordination activities (FGDC grants);
- facilitated a standards-based data transfer capability (allows state agencies and others who follow their lead to exchange data with federal agencies); and
- opened the door to cost-sharing and partnership arrangements with federal agencies.

Based in part on the solicitation of a partnership arrangement by the Council, the FGDC began an effort to establish partnership with all states. To date there are ten other states identified.

3.3.2 Cooperative Study with the Council on Competitive Government

Starting in the Fall of 1994, the Planning Council, the General Land Office, and the staff of the Council on Competitive Government (CCG) conducted a study of the efficiency of the state's use of GIS technology. This study was undertaken to try to identify where inefficien-cies exist and how they could be overcome. In general, the results of the study indicated that significant benefits are occurring from the coordination of GIS technologies through the auspices of the GIS Planning Council and the sharing of data resources through the Texas Natural Resources Information System. During the course of the study several action items for improving the efficiency of GIS in Texas were identified. Progress has been made on each action item identified.

Streamlining the efficiency of purchasing of GIS related technology was identified as a potential cost-saving mechanism early in the study. The Planning Council and its member agencies have committed to using the GSC Catalogue as a first resort for purchasing GIS related technologies and as a forum for services available to other agencies. The Texas Department of Criminal Justice has placed its services on the GSC catalogue as a first step toward making the catalogue a central piece in the acquisition of GIS technology.

The work with the CCG staff was instrumental in several of the achievements of the Council during 1996–97. CCG influenced the council to pursue grants, joint purchasing mechanisms, and plan the merger of the Planning Council and the TNRIS Task Force.

3.3.3 Grants and Cost-Sharing Success

The largest monetary benefit to occur as a result of this study lies in the realm of funding. With the help of CCG staff, the Department of Information Resources, on behalf of the Council, was able to secure authorization from the Office of State and Federal Relations in June of 1995 for approximately $1.5 million to support the Council's Base Mapping initiative (see TOP discussion in Chapter 5). With this commitment in hand, DIR was further able to secure approximately $3.0 million from federal sources.

With support of the CCG staff, DIR, as an agent of the GIS Planning Council, was able to secure $1.4 million in grant matching funds from the State Match Pool (SMP) for developing an up-to-date public domain base map for approximately one third of the state. The SMP fund was created by the 72nd Texas Legislature to help agencies secure federal grants and promote economic development in Texas. It is administered by the Office of State and Federal Relations (OSFR). Based on the SMP award, DIR was also able to secure $3 million in federal funds through the Innovative Partnerships Program managed by the U.S. Geological Survey. It is anticipated that local contributions will bring the total funding for the project up to at least $5.5 million. Additional support from the private sector is expected, making it likely that the program will continue to grow. Our intent is to continue the project to support acquisition of this data statewide.

Through this project, the state will be leveraging each dollar with at least three dollars from other sources. The products created will provide for improved alignment of government information systems and promote economic development; directly through use of Texas-based contractors, and indirectly through providing all of the resulting digital data products in the public domain. The value of this information to land development activities, market and infrastructure planning and management is extremely high. This information will fuel the economy and provide for better decision making in a broad cross-section of Texas government and the economy.

3.3.4 Cooperative Contract with ESRI

Also as a result of the CCG study, DIR negotiated a Cooperative Contract with Environmental System Resources Institute, Inc. (ESRI) of Redlands, California for acquisition of GIS software and services. Though, as a rule, DIR does not endorse specific proprietary solutions, it does have the authority to develop cooperative purchasing arrangements. This arrangement takes advantage of the significant purchasing power of the state to develop favorable purchasing pricing, terms, and conditions for products in high demand. ESRI has maintained 60 to 80 percent market dominance in the state for GIS software for several years.

During negotiations, DIR was able to secure the deepest cost reductions on software available to any ESRI customer, including the federal government. DIR was also able to secure reductions in software maintenance costs for both current and new users of the software. This too is a first for any ESRI customers.

All governmental entities in the state, including school districts, are eligible to purchase off DIR's Cooperative Contracts. While it is difficult to estimate the cost savings that will be achieved through this program, it is expected that savings will accumulate to about one hundred thousand dollars in the first year and may average as much as five hundred thousand annually in later years.

3.3.5 TNRIS Task Force/GIS Planning Council Merger Plans

In January 1996, the TNRIS Task Force and the GIS Planning Council formed a joint Working Group to study the roles and responsibilities of both committees to identify duplication and recommend actions to streamline the state's approach to GIS and geospatial data management and coordination in Texas. It was found that there were several areas of overlapping responsibilities between the two groups. It was the recommendation of the Working Group that the two committees should be merged. A joint resolution calling for the merger of the two committees, was passed by both committees in June of 1996 (see Exhibit 3.4). As a result of this resolution passing, a joint committee, called the Blue Ribbon Committee, was established to develop a proposed new charter and address transition issues. This process is currently underway.

3.3.6 The Council's Texas/Mexico Border Region Subcommittee

During the 1995–96 biennium Council formed the Texas/Mexico Border Region (TMBR) subcommittee. This new subcommittee was established to focus state efforts associated with the border region and serve as a liaison between the Council and the Transboundary Resources Inventory Project. It is also providing oversight and direction for the Border Information Center (BIC) which is housed at TNRIS (see 3.3.7).

The recommendations in Exhibit 3.5 were sent to the Secretary of the Interior from the Planning Council in April of 1996. They were proposed by the TMBR subcommittee after consultation with representatives of the White House's Council of Environmental Quality (CEQ), and the Transboundary Resource Inventory Project.

3.3.7 TMBR Sponsorship of Border Information Center at TNRIS

The relationship between the Texas/Mexico Border Region subcommittee and BIC is a product of the on-going Council/TNRIS merger discussions. As such, it represents a precursor to the future relationship between the new merged committee and TNRIS.

An important state initiative which impacts data collection and dissemination along the Texas/Mexico border is the Texas/Mexico Borderlands Information Center (BIC). BIC was established in 1993 as a component of the Texas Natural Resources Information System (TNRIS) with the following objectives:

1. To make information related to the natural resources and demographics of the border region available in a timely and efficient manner to researchers, plan-ners, and others with responsibilities for protecting the environment, public health and well-being of the borderlands region.
2. To promote closer ties, communication, and data sharing among entities with border responsibilities and thereby reduce redundance in data collection and project activities.

BIC provides the Texas/Mexico border region essentially the same services which its parent organiza-tion, the TNRIS, provides the state as a whole. It serves as a clearinghouse and referral center for numerous types of data such as maps, aerial photographs, water data, weather data and Census data. The unique feature of BIC, however, is that it provides these services for Mexican as well as Texas data.

One of the BIC tasks is to inventory border-region GIS data layers that are available from governmental and other entities in the state. The project will be based, not on acquiring the data files themselves, but on describing them according to the FGDC metadata standards. Results of the inventory will be made avail-able via the Internet with links, where appropriate, to the data sources.

BIC is located in the TNRIS offices (1700 N. Congress Ave., Stephen F. Austin Bldg, Rm. B40, Austin, 78711; web site: http://www.tnris.state.tx.us; phone: 512/463-8337). Full-time bilingual staff are available to respond to requests for data from either side of the border.

3.3.8 Council Participation in GSC Pricing Study

By direction of the 74th Legislature of Texas, the Council participated in a GIS data pricing study conduc-ted by the General Services Commission during 1996.

WHEREAS, the Texas Natural Resources System (TNRIS) Task Force was established in 1972 to provide guidance to the Executive Administrator of the Water Development Board for the operations of the Texas Natural Resources Information System (Vernon's Texas Water Code, Section 16.021), and

WHEREAS, the Task Force has functioned in the above capacity, meeting on a regular bi-monthly basis for the past 24 years, and is currently composed of 17 member agencies plus the Office of the Governor, and

WHEREAS, the TNRIS, under the guidance of the Task Force, serves in the capacity of clearinghouse and referral center for natural resource data, education center for information technology, and liaison with the federal government for natural resource data dissemination, and

WHEREAS, TNRIS has developed a major geographic information system capacity and provides project and technical support for member TNRIS agencies and also supplies GIS users with digital data layers, much of the data now being made available over the Internet, and

WHEREAS, the Texas Geographic Information Systems (GIS) Planning Council was established in 1990 to provide guidance and coordinated direction for the development of GIS technology in Texas State government and, in 1992, was empowered by a Governor's Executive Order to serve in this capacity, and

WHEREAS, the GIS Planning Council meets quarterly and currently is composed of 35 member entities from several levels of government, with administrative support provided by the Department of Information Resources, and

WHEREAS, there is considerable overlap in membership between the two organizations with 13 TNRIS Task Force members also serving on the Planning Council, and there is also some overlap in responsibilities, particularly in the areas of education and liaison functions with the federal government, and

WHEREAS, the GIS Planning Council, through its document, the "GIS Implementation Plan," identified TNRIS as the Internet "Hub" for facilitating natural resource data exchange among State agencies via the Internet, and

WHEREAS, the GIS Planning Council has proposed that TNRIS be a center for distribution of the newly-acquired digital orthophoto quadrangles (DOQ's) of the State, and

WHEREAS, a working group composed of members of the GIS Planning Council and the TNRIS Task Force has recommended that TNRIS be the coordinating entity for completing a Statewide base map utilizing the DOQ's and other materials, and

WHEREAS, to accomplish the above tasks—Internet "Hub," DOQ distributor, and base map coordinator—TNRIS will require additional resources, and

WHEREAS, a working group composed of TNRIS Task Force and Planning Council members has recommended merging the Task Force and Planning Council into a single committee to achieve the following benefits:

- achieving overall efficiencies by combining the Planning Council's planning functions with TNRIS's operational functions under a single guidance committee
- providing a common point of contact for the federal government in matters related to coordinated data dissemination
- providing greater leverage for seeking additional support for TNRIS

THEREFORE BE IT RESOLVED, that the members of the Texas Natural Resources Information System Task Force and the Texas Geographic Information Systems Planning Council recommend that the TNRIS Task Force and the GIS Planning Council be combined into a single committee and that the committee include in its mission statement the responsibility for providing guidance to the Texas Water Development Board Executive Administrator for operating and maintaining the Texas Natural Resources Information System and guidance to the Department of Information Resources on statewide geospatial information standards, and that a blue ribbon committee be jointly appointed to further develop and coordinate the merger.

(Passed by the TNRIS Task Force on June 14, 1996, and the Texas GIS Planning Council on June 21, 1996.)

3.4 Future Partnership Plans

There are three objectives for FY 1998–98 activities related to the partnership initiative. These are:

1. Recertification of the Council as a cooperating partner with the Federal Geographic Data Committee (FGDC) in development of the National Spatial Data Infrastructure (NSDI),
2. Merger of the TNRIS Task Force and the GIS Planning Council, and
3. Development of a regional partnership program that includes formal recognition of regional GIS coordination efforts in Texas and supports the goals of NSDI.

Accomplishment of these objectives will build upon the accomplishments of the current biennia to ensure optimal organizational structures to support effective and efficient use of GIS and other geospatial technologies in Texas. The Partnership Resolution, passed in 1994, calls for the actions described in items one and three above, and the joint resolution of the Council and Task Force addresses item two. Thus no additional resolutions are needed to support these activities.

3.4.1 Recertification by FGDC

The goals of the FGDC are to facilitate cooperation among all stakeholders with an interest in geospatial data development and use. The FGDC actively encourages interested parties to be recognized as partners in their efforts to implement a seamless National Spatial Data Infrastructure (NSDI). Partners must demonstrate their commitment to support FGDC goals regarding data development and data clearinghouse activities (including accepting compatible standards for data transfer and documentation, and data sharing). In addition to recognition, cooperating partners have the opportunity to affect the evolution of federal policies, standards, and activities and are provided a direct link to the highest levels of the federal agencies that are using this technology. Benefits to the state also include improved access to data developed by the federal government though use of compatible systems.

Partnerships with FGDC are generally active for two years. Texas was the first state recognized as an FGDC cooperating partner in January 1995. The Council needs to solicit FGDC acknowledgment of its status as a cooperating partner in January 1997. By taking this action, the Council will demonstrate to FGDC and its participants that Texas remains a willing and important contributor to FGDC's nationwide efforts. A written request will be sent to the FGDC Secretariat stating the Council's purposes for recognition, Council members, and a description of the data categories and geographic regions of interest to the Council. The FGDC Secretariat will review the application and present it for review at the next FGDC Coordination Group meeting.

3.4.2 Merger of the TNRIS Task Force and the GIS Planning Council

The merger of these Committees will streamline GIS organization in the state (elimination of repetitive functions, meetings, and subcommittees), provide a single point of contact for federal agencies, and allow the resulting committee to draw upon the resources of TNRIS and DIR.

This merger is expected to take place on or before September 1, 1997. The Texas Water Development Board, which houses TNRIS, will propose during the 75th Legislature new legislative language that reflects this merger. Though the name for the new committee has not yet been finalized, at the November 1996 meeting of the Council, the name Texas Geospatial Information Council (TGIC) was endorsed. The solicitation for continuing recognition of state coordination efforts by FGDC, discussed in 3.2.1, will indicate that this new body is likely to replace the Council in September 1997.

Benefits of this new alignment will include:

1. Improved standards setting through formal link of central clearinghouse at TNRIS and standard setting authority at DIR
2. Streamline government (single point of contact for feds, reduction of the number of committees from 9 to 5, and the number of meetings of these committees from 40 to 16)
3. Create more efficient link between GIS policy setting and implementation

3.4.3 Recognition of Regional Efforts

One of the actions advocated in this document, is for the Council to use a similar approach within the state that FGDC is using to build the organizational structure to support the National Spatial Data Infrastructure (NSDI) at the national level. The first step in this process, is to further define the program (to be done by the end of FY 1997 by the Managers Committee). The second step will be to solicit Regional Geographic Coordinating Councils within Texas. These regional entities can serve to coordinate regional and local GIS activity with the Council, assist in implementing data-sharing standards, provide a conduit for cost-sharing, and help to build Texas' spatial data infrastructure.

Councils of Government (COG) were identified in the 1992 Texas GIS Business Plan as appropriate entities for coordinating GIS activities between the state and regional/local governments. COGs are a natural choice for this activity: they cover the entire state, are designated as regional planning entities, and, in many cases, are already disseminating data. Representatives of the Texas Association of Regional Councils (TARC), who have long participated in the Council and in developing the Texas Statewide GIS Implementation Plans, have expressed a desire to have the COGs coordinate GIS activities and provide digital data sharing services for the regions.

During the 1998–99 fiscal biennia the Council will seek to implement a program for recognition and partnerships with regional geospatial coordination efforts in the state. This program will work much like the FGDC cooperating partners program discussed above. It will have three primary aspects:

1. Recognition of local/regional cooperative efforts by the Council,
2. Certification of local/regional implementations of clearinghouse technologies (see Network Data Access initiative discussion in Chapter 4), and
3. Integration of data generated at the local/regional level into the StratMap program (see Base Mapping initiative discussion in Chapter 5).

By the end of FY 1997, the Council will establish a policy for acknowledging and recognizing entities coordinating local/regional geospatial efforts (provided they follow the general goals of the Council and FGDC). This recognition will aid in creating a better means to exchange data, help ensure that data produced meet the needs of the citizens of Texas, and establish set points of contact. Local and regional groups will benefit through increased data exchange and access to selected resources of the Council. This will also help these groups receive financial support from state and federal entities in producing digital base maps that meet common needs.

The GIS Managers Committee is charged with further refinement of this program. The objective is to have a formal mechanism for recognizing cooperating entities in place by September 1997. Though not identical to the federal program, it is likely that the state program will be very similar to that described in Appendix A.6.

These new aspects of the partnership initiative will enhance GIS cooperation, cost-sharing, and data exchange among local, regional, state, and federal agencies. A number of benefits will accrue to regional and local jurisdictions as a result of developing partnerships with the Council. Chief among these are the opportunity to substantially participate in the statewide data-sharing and base mapping initiatives. These formal partnerships will help standardize these efforts across sectors of government and the economy and will enhance operational interaction among agencies while saving money.

Given the increased use of geographic information systems on the local level as well as at the state level, it is imperative to have an agreed-upon map base on which to overlay data from diverse jurisdictions accurately and quickly. There is a wide assortment of maps and map bases throughout local jurisdictions in Texas. Data developed at the federal level often does not take account of state or local jurisdictions. FGDC has initiated a program called the National Spatial Data Framework, whereby data generated

1. Develop a real-time GPS correctional broadcast network in border area.

   A real-time GPS correctional broadcast network would optimize the cost efficiency and accuracy of collecting locational information along the border. Consistent and uniform GPS data would be available for collection by both public and private sector entities. Real-time correctional broadcast will allow for a more efficient means of collecting valuable data needed for developing base maps and specialized spatial data.

2. Require locational coordinates for the physical location of all federally permitted activities.

   Collecting accurate coordinates on permitted activities will improve the effectiveness of permitting, monitoring, and enforcing regulatory requirements within the border region. Accurate facility locations will help both the permittee and regulatory agencies in planning and policy issues. The Planning Council is supporting an initiative to require this information on activities permitted by the state of Texas as well.

3. Develop work-share arrangements between federal and state government agencies for border base map development.

   Implementation of strategic work-share and cost-share arrangement between federal and state agencies for development of critical spatial data will speed up the creation of a true national spatial data infrastructure. Such arrangements will maximize the use of available resources for co-developing base map data and other important spatial information, and should be implemented as soon as possible for base map layers like hydrography, hypsography, transportation, soils, and address matching updates.

4. Involve State NSDI Cooperating Partners explicitly in the Border 21 Initiative (particularly on spatial data subcommittee).

   The Texas GIS Planning Council has an excellent history of coordinating state geospatial data development and would be a crucial component in any geospatial data development effort along the Texas border. Similar organizations exist, and have been recognized by FGDC for other border states.

5. Establish TNRIS as a distribution center for data currently being produced through USGS, EPA, and other federal entities building data for the border.

   TNRIS is the state of Texas repository for geospatial information and houses the Borderlands Information Center. TNRIS is also a member of the Earth Science Information Center (ESIC) network supported by USGS.

at the state and local level can be imported into the national databases so that data development costs can be minimized and the overall database can be kept as up-to-date as possible. Involving the federal government in a formalized arrangement with state and regional entities provides an excellent way to address the needs of this technology.

4.0 Data Sharing Initiative

An enormous amount of geospatial data for Texas has been digitized and is available through TNRIS and other sources. For example, the Texas Department of Transportation (TxDOT) has completed digitizing the public roads in Texas at a scale of about 1:24,000. Similarly, the Railroad Commission (RRC) has completed digitizing the Original Texas Land Survey (OTLS) and other base map layers in addition to completing the digitizing of oil and gas well locations for the state. These projects, which took nearly ten years to complete, represent a significant investment of time and financial resources. The option for acquiring digital data through data-sharing was not available at the time these projects were initiated, but it is clearly available today.

The data sharing initiative will help ensure that investments such as the ones made by TxDOT and the RRC (and the others as indicated in Appendix C) are used by other agencies. As a result of this initiative, agencies that need data in the future, will have every reasonable opportunity to locate existing data before they make investments in digitizing it.

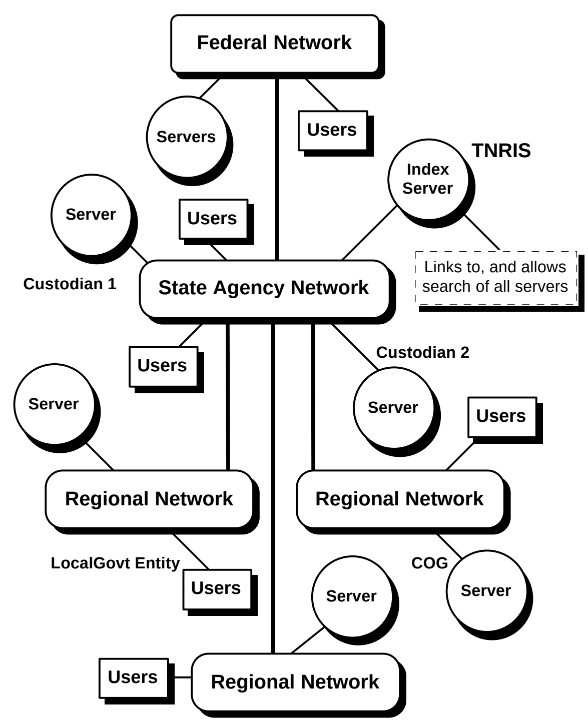
The data sharing initiative calls for strategically located data servers to be connected to the Internet and interlinked in a standards-based environment that will facilitate base map data layer sharing among state agencies and support data sharing between state agencies and entities at the federal or local levels.
Exhibit 4.1 illustrates the structure of the data sharing system that will result from the combination of the Partnership Initiative, described in the previous chapter, and the data sharing initiative, described in this chapter.

4.1 Discussion of the 1994 Resolution

In 1990, the six Charter Member agencies in the Council signed a Memorandum of Agreement to coordinate their GIS activities. The Geospatial Data Sharing Resolution (see Exhibit 4.2) was passed by the Council on November 22, 1994. The resolution expands this coordination to commit a greater number of agencies to share data.

The Council continues to build upon establishing a system that makes information sharing a priority. The entities that would benefit most from an open information environment like this would for the most part be state agencies, county and local groups and those from the private sector. This information technology sharing environment would make data availability a primary goal.

The Network Data Access Coordinating Committee will continue to meet to help maintain communication between existing and new GIS/Internet users. These meetings will provide a forum for the evolution of a standards-based approach to using the Internet for sharing GIS data.



Training opportunities will be identified and coordinated so that numerous agency personnel may participate. On-site presentations and demonstrations will be given to help convey data sharing among state agencies.

4.2 Federal and National Trends

In addition to identifying state GIS coordinating councils, the FGDC is leading the effort to enhance data-sharing capabilities, notably by endorsing a set of tools and standards referred to as the NSDI Clearinghouse tools, which facilitate electronic exchange of geospatial data. The tools being endorsed by FGDC are made to run via the Internet, a wide area communications network that allows computers and networks of different designs and architectures to communicate (the Internet is discussed in greater detail in Appendix B).

The Spatial Data Transfer Standard (SDTS), described in Federal Information Processing Standard (FIPS) publication #173, is one of the tools FGDC is advocating for use in the NSDI Clearinghouse program. This standard provides specifications for the organization and structure of digital spatial data for transfer between systems. The purpose of the standard is to facilitate transfer of digital spatial data between dissimilar computer systems while preserving information meaning and minimizing the need for external information. Use of SDTS is expected to overcome difficulties in transferring digital spatial data without regard to storage and maintenance systems. As of February 14, 1994, all new federal purchases of GIS systems are required to be SDTS compliant, i.e., able to encode to and decode from the SDTS format.

Full adoption of SDTS will mean that, for the first time, a non-proprietary data exchange format will be common to a broad cross section of proprietary GIS software. This is of significant interest to users and producers of digital spatial data because it will increase their capability to share spatial data and reduce information lost in data exchange.

Another area of interest in tools for sharing data or any other spatially-oriented resource over the Internet is the work from the Open GIS Consortium, Inc. (OGC). They are a unique membership organization dedicated to open system approaches to geoprocessing. By means of its consensus building and technology development activities, OGC has had a significant impact on the global geodata and geoprocessing standards community, and has successfully promoted a vision of Open GIS technologies that integrate geoprocessing with the distributed architectures of the emerging global information infrastructure.

WHEREAS, as executives of state agencies participating in the use, management, and analysis of human and natural resource data for the State of Texas, we recognize the importance of GIS technology and the value of geospatial data resources for support of decision making and in provision of quality service; and

WHEREAS, the Federal Government, through the Federal Geographic Data Committee (FGDC), has taken a leadership role in advocating an inter-related suite of standards for the purpose of accessing, evaluating, transferring, and converting geospatial data in support of developing a National Spatial Data Infrastructure (these standards include Client/Server tools, the Spatial Data Transfer Standard (SDTS -- FIPS 173), and Geospatial Metadata content standards); and

WHEREAS, successful implementation of these standards will require that practitioners pilot, evaluate, and help the standards to evolve; and

WHEREAS, mature geospatial data access and transfer standards will make the state better able to use the wealth of geospatial data maintained at federal, state, and regional levels, and will improve exchange of information between government and non-governmental entities; and

WHEREAS, we, the Geographic Information Systems Planning Council, having been duly authorized by Department of Information Resources Charter and directed by executive order of the Governor, have produced plans for coordination and implementation of GIS technologies statewide that rely on good data sharing capabilities;

NOW THEREFORE, we resolve, within budgetary limitations, to develop workable implementations of the geospatial data sharing standards sponsored by Federal Geographic Data Committee to make geospatial data developed by our agencies, that is not private or sensitive, available electronically over computer networks, and to sponsor adoption of these standards at regional and other levels in Texas.

OGC recognizes that the evolution of new technologies and new business models are closely related. By means of an open and formal consensus process, OGC is creating the Open GIS Specification, an unprecedented computing framework and software interface specification which is a necessary prerequisite for geoprocessing interoperability. Through meetings, promotional activities, publications, and the network it nurtures, OGC also educates the industry and promotes development partnerships, business alliances, and market demand for new geotechnology-based products and services.

The Geospatial Metadata Standard (Metadata) is another tool FGDC is advocating to facilitate data transfer. Metadata is a data layer documentation standard that provides the information a potential user might need to evaluate usefulness of any given data layer. Metadata includes the scale, projection, and lineage of the data as well as a wealth of other information about any given data layer.

In addition to the non-proprietary data exchange format (SDTS) and a standardized description of the data content (Metadata), the FGDC has been advocating use of client/server tools that use the power of the Internet to search out and retrieve data files. Zserver and WWW browsers are two client/server tools FGDC recommends. Zserver (Z39.50), developed and maintained by CNIDR Isite, which is an integrated Internet publishing software company that is an adaptation of a public domain client/server product and does the following:

- takes advantage of the Internet to allow broad access,
- uses indexed Spatial Metadata files to provide key word search capabilities,
- allows users to seek appropriate data layers according to geographic coordinates,
- allows the perusal of text and image files to determine potential value of data layers,
- allows the transfer of data layers from any of a large number of servers to any user on the network, and
- works in regard to the NSDI content standards for digital geospatial metadata.

WWW browsers and servers have slightly different capabilities than the Zserver. The FGDC, by endorsing this suite of standards for the NSDI Clearinghouse, has provided a highly constructive set of tools that can be used to address the operational needs for GIS data exchange in Texas. By using these standards, agencies will be able to significantly reduce duplication of effort and focus on increasing the quality and integrity of spatial data.

4.3 Data Sharing Technological Trends

This initiative relies primarily on two technologies: client/server tools and Internet connectivity. It also relies on adoption of the FGDC-sponsored standards (primarily geospatial Metadata and Spatial Data Transfer Standards or SDTS). Two important issues which need to be considered in implementing these data-sharing technologies are the way security risks will be handled and the level of detail appropriate to document layers. Several state agencies are involved with pilot projects which address these issues.

4.3.1 TNRIS Role

For over 20 years, the Texas Natural Resources Information System (TNRIS) has served as a data clearinghouse and referral center for information concerning the state’s natural resources. This experience, combined with its modern data storage and transfer capabilities, make TNRIS an excellent choice to continue as a location for a centralized electronic catalog for data supplied by state agencies.

TNRIS has created an Internet node for the Z39.50 http gateway server software to create an accessible user interface to its GIS metadata database. The node will incorporate FGDC policies and standards for data collection, storage and transfer. Users will be able to download TNRIS GIS data, obtain data information, and communicate with TNRIS staff. Internet users will also be able to access other state, federal, and local servers through the TNRIS node. Listings of other agencies’ holdings will be available through the TNRIS node. This node will promote FGDC goals and provide a major point of access for Texas natural resource data.

Cooperating partners for this project include the Texas Natural Resources Information System, Texas Water Development Board (primary contact), General Land Office, Texas Parks and Wildlife Department, Texas Department of Transportation, Texas Railroad Commission, Bureau of Economic Geology, Office of the Governor, Texas Natural Resource Conservation Commission, Texas Forest Service, Texas Department of Commerce, Texas Department of Health, Texas Department of Agriculture, Texas State Soil & Water Conservation Board, Texas Historical Commission, Texas Office of State-Federal Relations, and the Office of the Attorney General of Texas.

Clearinghouse for Networked Information Discovery and Retrieval—The Clearinghouse for Networked Information Discovery and Retrieval (CNIDR) continues development and maintenance of Isite, a complete Internet information system. Isite integrates database systems with other open Internet systems and protocols such as the World Wide Web, Gopher, electronic mail and, primarily, ANSI/NISO Z39.50. The primary protocol, Z39.50, offers a variety of search and retrieval facilities suitable for complex database operations. Isite includes all Z39.50 communications applications as well as an http to Z39.50 gateway and a complete text search system, Isearch. See Exhibit 4.3 for an overall architectural view.

4.3.2 TNRIS Responsibilities as Internet Hub

TNRIS is identified by the GIS Planning Council as a principle "hub" for dissemination of natural resource and census data over the Internet. TNRIS has the following responsibilities in filling this hub role:

- Educate data custodians regarding the benefits of participation in a standardized reporting (metadata).
- Make available appropriate metadata builder tools to data custodians.
- Instruct state agencies and other data custodians in the application of FGDC metadata standards.
- Encourage each data custodian to be responsible for maintaining its own metadata documentation and for providing access to its data either directly or via links with the TNRIS server.
- Provide Certification Program.

4.3.3 Advantages to Interoperability

Distributed File System—A common benefit of using a Distributed File System for Internet and intranet applications is that Distributed File Systems provide scalable, available, manageable, and secure access to files—the very attributes that most Internet or intranet-based web sites need to ensure continued expansion, especially in GIS applications. Exhibit 4.4 summarizes the positive aspects of interoperability.

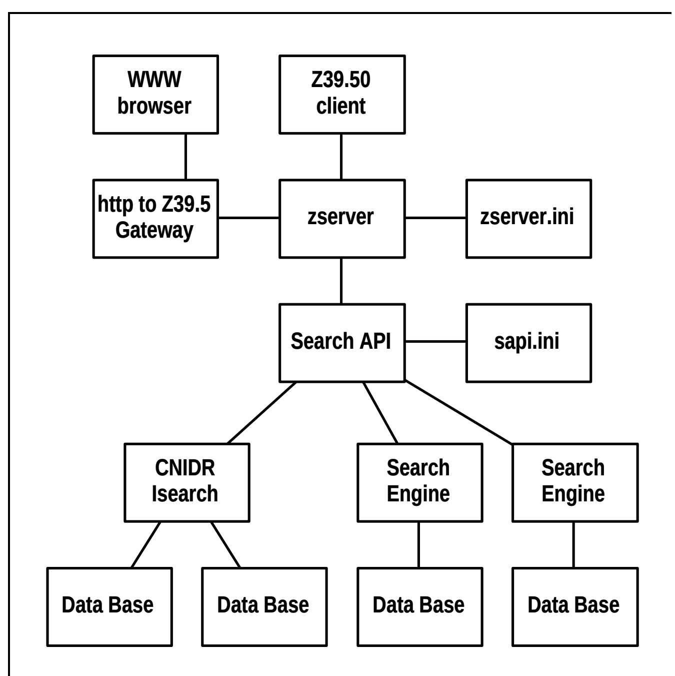
Universal Resource Names—Universal Resource Names requirements are explained so as to provide complete understanding about the functionality of this naming system. A URN is a name with global scope which does not imply a location but has the same meaning everywhere. The same URN will never be assigned to two different resources. It is intended that the lifetime of a URN be permanent. That is, the URN will be globally unique forever, and may well be used as a reference to a resource well beyond the lifetime of the resource it identifies or of any naming authority involved in the assignment of its name. URNs can be assigned to any resource that might conceivably be available on the network, for hundreds of years. The scheme must permit the support of existing legacy naming systems in so far as they satisfy the other standard requirements. Any scheme for URNs must permit future extensions to the scheme. It is solely the responsibility of a name issuing authority to determine the conditions under which it will issue a name.

These requirements focus on the URN, but make no assertions about the resource that it identifies. A URN may be globally unique and last forever without any guarantee that the resource identified by the URN is unique or permanent.

Any registry is capable of registering resolution services for any URN scheme, and a client may wish to consult multiple registries when attempting to resolve a name.

4.4 Specific Accomplishments Since 1994

Some accomplishments of Data Sharing Projects that TNRIS has been a part of are the WetNet project (funded by the EPA) and the Water Quality project.



High availability—Many documents at a typical Web site change infrequently, making them candidates for system replication. With replication, users experience no interruption in service if a server machine fails. SYSTEM enables administra-tors to perform common operations such as backup and restore, and to move volumes from one machine to another without taking any part of the file system off-line.

Excellent scalability—Replication enhances scalability be-cause multiple copies of Web objects on multiple machines are accessible by many more users than a single copy on one machine. Because all system file names are completely loca-tion-transparent— file path names never contain mount point or other location information—administrators can partition data efficiently across disks and machines. Files can be moved, and additional machines and disk resources can be brought on-line, without having to change any content or URL references.

Better security—Because a Distributed File System supports an access control list (ACL) mechanism, it is easy to control which users can access specific web documents and objects. ACLs also make it easy for system administrators to exercise a high degree of control over access to Intranet Web site content. Administrators can specify that all users may read some documents, only specific groups of users may read others, and that certain documents may be changed only by administrators. SYSTEM will ensure that responses come only from authen-ticated servers, greatly reducing the chance that false or mis-leading information can be published by non-authorized users.

Improved performance—Distributed system clients cache information locally, improving response times and greatly reducing network loads. The system can further increase perfor-mance by automatically pre-fetching data, adjusting to intermit-tent network problems, and optimizing access to replicated information. In the case of Intranet configurations, the file transfer protocols used internally by a distributed file system have been shown to work faster and more efficiently than HTTP, leading to reduced network traffic and response times.

Easier administration—Client and server machines are grouped into administrative domains called cells. Cells can correspond to an Internet domain, or domains can be partitioned into multiple cells. Each cell forms a complete and stand-alone file sharing environment with control over all aspects of administration such as backup, restore, disk resource partitioning, and security. This type of system enables administrators to group related files into distributed file system filesets and manage them as a unit. This environment can support remote administration—configuration changes can be made from anywhere in a network and don't require physical access to the machines where the file servers are running. Cells can be transparently linked together into much larger networks of cells, enabling administrators to design extremely large-scale, yet manageable, distributed file systems.

Naming schemes and resolution systems—The framework distinguishes between naming schemes and resolution systems. A naming scheme is a procedure for creating and assigning unique URNs that conform to a specified syntax. A resolution system is a network-accessible service that stores URNs and resolves them.

Independence between naming schemes and resolution systems—A naming scheme is not tied to a specific resolution system. Any resolution systems is potentially capable of resolving a URN from any given name scheme.

URN registries—Since naming schemes and resolution systems are conceptually independent, mechanisms must be created so that the user of a URN can discover what resolution systems are able to resolve the URN. This is called a URN registry or simply a registry.

Multiple independent naming schemes and resolution systems are anticipated. Although the maintainer of a particular URN resolution system may also wish to maintain a registry, it is important to realize that registries and URN schemes are conceptually independent of one another.

4.4.1 WetNet

In 1994, five Texas state agencies and four federal agencies participated in an effort to develop a prototype system for sharing wetland resources information over the Internet. The pilot project produced an online, distri-buted database structure based upon currently available technology which would enable government agencies, academic institutions, and the general public to effici-ently access, view, download, and exchange data related to wetland resources. During the pilot project, partici-pating agencies were able to conduct online exchange of wetlands-related data across many hardware platforms and in a variety of formats, including textual, vector, and raster information. The pilot project demonstrated that wetland-related data could be successfully viewed and downloaded from distant computers, and then overlaid with base map data for spatial analysis.

In the summer of 1995, a continuation grant to the pilot project was approved by the Wetland Office of EPA Region 6. The Texas Wetland Information Network (WetNet) project will fully implement the information exchange network that was tested in the prototype. WetNet will empower key users of the networked system by moving the technology onto the desktop of staff at participating agencies; expand the information exchange network by increasing the number of participants; and educate non-participating represen-tatives of local governments, academic institutions, and public organizations regarding the availability of wetland-related data through the network. Using the World Wide Web and an online data catalog, WetNet will enable resource managers and the public to display and download wetland-related information housed at state and federal regulatory agencies.

In addition, WetNet will be a test of the Spatial Data Content Standards for metadata advocated by the FGDC. FGDC is a federal interagency coordinating body charged by presidential executive order to develop means to share GIS data among federal entities and between federal, state, and local governments. Users will be able to view descriptive text, called metadata (including source, scale, date, etc.), about the spatial data accessed through WetNet in a format based on the FGDC metadata form.

The driving force behind the Texas WetNet project is a desire to improve the protection of wetland resources through improved exchange of key information that is housed within state and federal agencies. When fully implemented, the technology and networking structure developed in WetNet will greatly enhance wetland protection efforts in Texas. The success of wetlands regulatory programs and the efficiency of state and federal permitting activities can be dramatically improved by access to accurate, timely, and comprehensive data.

4.4.2 FGDC Grants in Texas

TNRIS: An NSDI Internet Node for the State of Texas—The Texas Natural Resources Information System solicited and won a funding proposal project from the U.S. Geological Survey, Federal Geographic Data Committee for advancing the development of the National Spatial Data Infrastructure (NSDI) in October of 1994. This effort is referred to as the NSDI Internet Node for the State of Texas.

The NSDI Internet node project was conducted as an interagency effort, with participation by the TNRIS Task Force, the Remote Sensing and Cartographic Committee of the Task Force, and the GIS Managers Committee of the statewide GIS Planning Council.

This interagency working group successfully developed an NSDI on-line Internet node structure based upon GIS technology and information resources technology which enables government agencies, academic institutions, and the general public to efficiently access, manipulate, and exchange data related to natural resources.

The driving force behind this project has been a need to improve the ability to identify what data exist, the quality of data, and how to access and use the data by reducing wasteful duplication of effort and by improving cooperation. The project has produced an Internet-based, on-line network which uses a “distribu-ted” network structure where information is not always gathered into a single large computer, but can remain within the custodial agency that developed the data.

During development of this system, natural resources data stored at the participating agencies were indexed (catalogued) and made available via the Internet on a SUN SPARCstation 20 and other computer platforms. The networked NSDI node system was originally developed using spatial-WAIS (Wide Area Information Server) and Mosaic, a multi-media viewer program for the Internet (both of which are public domain software). Using the NSDI node (TNRIS NAVIGATOR) system, participating agencies have been able to conduct on-line exchange of natural resources related text (databases), mapped (vector), and photographic (raster) information.

The NSDI Internet node has been one of the first of its kind in the state. As intended, it has been a good test of the GIS data exchange standards advocated by the FGDC.

LCRA—The Lower Colorado River Authority (LCRA) received funding through a National Spatial Data Initiative (NSDI) Cooperative Agreement to pursue the creation of a metadata tool to assist in organizing GIS data sets at LCRA. The NSDI Cooperative Agreements are administered by the U.S. Geological Survey. DIR teamed up with LCRA to help build the tool and inves-tigate the possibility of promoting use of the tool for statewide metadata organization.

The grant was originally written to provide a beginning metadata entry and search tool primarily for LCRA purposes. Other participants included DIR, Texas Parks and Wildlife Department (TPWD), and Texas A&M University (TAMU). The same participants were still included in the project although the project scope and deliverables have changed slightly. The time line was changed so that the project will run through December, 1996. The metadata tool will now be created for a more generic platform installation, use with a variety of databases, and the tool will also be expected to be used by other agencies for their metadata collection and reporting. Due to this change, TNRIS—the natural resources data clearinghouse and referral center for Texas—joined the project. TNRIS is. This same change also increased DIR’s participation in the project.

DIR, as the primary information resource management planning agency for the state, supports the activities of the

Council. Using its administra-tive rule making authority, DIR has the ability to require agencies to report annually on their GIS holdings. The Coun-cil recommends the form and content for these reports. One objective of this project is to have the reduced metadata content developed adopted by the Council. The proposed LCRA metadata tool has defi-nite possibilities of providing an electronic means for metadata exchange, compilation, and reporting.

North Texas GIS Consortium—Coordinated by the University of Texas at Dallas, Bruton Center for Development Studies

Establishing an NGDC node for the Dallas-Fort Worth region: A model for Metropolitan Areas. The primary deliverable will be a functioning NGDC node with procedures in place to catalog data for the Dallas/Fort Worth areas according to FGDC Standards. Funding will enable the Center to make its existing holdings consistent with the Metadata standard, to expand the holdings of local data consistent with the standard and promote the concept of the NSDI in the DFW area.

Exhibit 4.6 Compliant Server Components Not Available

4.5 Network Data Sharing Future Plans

There are three objectives for FY 1998–99 activities related to the Network Data Sharing initiative:

1. Establishment and ongoing maintenance of an NSDI standards-compliant Internet accessible data server at TNRIS to provide access to all electronically available geospatial data in Texas, and to serve as a cornerstone for development of a network of NSDI standards-compliant data servers throughout the state,
2. Provision of all products of the Texas Orthoimagery Program and StratMap Initiative (if funded) through this system, and
3. Development of a training and certification program that will provide a clear path for agencies or other entities seeking to use/supply data in this network.

These activities will significantly build the capability of agencies to share data files over the Internet, and result in systematic integration of GIS data at participating agencies. By taking these actions, the state will reduce costs related to duplication of effort and improve decision making through improved access to the most appropriate data for problem analysis. The Network Data Sharing Resolution, passed in 1994, addresses the need for these actions and no changes to the resolution are needed to support these activities.

4.5.1 TNRIS NSDI Standards-Compliant Data Server

TNRIS will provide access to Texas geospatial data through its NSDI standards-compliant server. It will also support the defusion of these capabilities by providing tools to support metadata documentation as recommen-ded by the FGDC. Exhibit 4.6 provides a generalized view of the components of a compliant server.

4.5.2 Access to TOP and StratMap Products

TNRIS will provide access to all Texas Orthoimagery Program (TOP) and StratMap products through the server described above.

4.5.3 Certification Program

The staff of the GIS/Internet unit of TNRIS will work with the Council and Managers Committee to develop a certification program that will identify sequential levels of conformance to NSDI and Texas standards by the end of FY 1997. During the FY 1998–99 biennium, agencies will be able to solicit and receive recognition for accomplishing each level of certification; the highest level of which will certify full compliance with FGDC NSDI requirements.

Through this program, all state agencies, and all regional partners, that develop or maintain geospatial data will be encouraged to develop standards-compliant data servers on the Internet. Special emphasis will be given to development of these capabilities at base map data custodians sites. Exhibit 4.7 describes the characteristics of a fully compliant site.

4.6 Benefits

TNRIS has existed for 25 years solely for the purpose of sharing data. The Council's efforts have focused on the sharing of digital data since its inception in 1990. The data sharing efforts planned for FY 1998–1999 will make digital data sharing a reality in Texas.

The benefits of this data sharing are broad and numerous. Since data acquisition represents 80% of the costs of GIS systems, development of reliable systems for data access and exchange combined with the development of base maps represents a tremendous opportunity to reduce the overall costs of GIS implementation. As a result of these efforts, many GIS implementations may be able to be developed with little to no investment in geospatial data. Where additional data development is necessary, it can be done only for that data needed to augment existing data and not as duplicative efforts to build the same data constructed elsewhere. Furthermore, these cost-saving advantages extend to private, as well as public sectors. As a result, not only will Texas government be more efficient but Texas businesses will be more competitive.

The benefits from this network data sharing include:

- Enhanced operational interaction among government agencies in taxes (standardizing map products and avoiding duplication.
- Savings in data production and storage costs for all agencies involved in GIS (only one copy of a base map would need to be maintained and made available online.
- Improved interaction between state and federal entities
- State agencies will be better able to access and download digital data of federal entities.

- Metadata (descriptive fields) that describe a digital geospatial data set. These metadata elements may be stored locally in text files or in a database. Data elements must match fields and logic of the FGDC Content Standards for Digital Geospatial Metadata. Metadata must be provided in formatted text or marked-up in Standard Generalized Markup Language (SGML).
- Computer hardware to store the indexed metadata in various forms, connected to the Internet. Initial supported platforms include Intel (Linux), Sun, DEC, HP, IBM, and Data General (with support for Windows-NT).
- Z39.50 software that supports access to metadata using the Geospatial Metadata Profile (GEO). The FGDC is offering one software reference implementation that supports the indexing and serving of FGDC metadata. An additional implementation will be made available at a later date to provide linkage between a Z39.50 server and a relational database.
- Metadata Parser Software (optional). The metadata parser (mp) program supports validation and reformatting of FGDC metadata into SGML, HTML, TEXT, and DIF formats from TEXT or SGML. It is recommended for the quick and standard generation of HTML for Web clients and for the creation of SGML for data exchange and indexing.
- World Wide Web Server (optional). Primary discovery and access to geospatial metadata in Clearinghouse is via the Z39.50 service, providing field-level search capabilities. Sites may wish to provide a customized "front-door" view of their site to complement the "back-door" search enabled by Z39.50.

5.0 Base Mapping Initiative

5.1 Description of 1994 Initiative

5.1.1 Base Map Development

An accurate, consistent, and up-to-date base map is the critical foundation of GIS. The primary, initial data development initiative in this plan is the Texas Orthoimagery Program (TOP). TOP will produce a highly accurate, consistent, and up-to-date color infrared (CIR) raster base map built upon digital ortho quarter-quads (DOQs) for the state. Requirements of a good base map are described in Exhibit 5.1. In addition to their rich informational content, the DOQ can be used as control for digitizing and updating other thematic layers of digital data to consistent standards.

1. **Consistency in time**—Ideally a base map will have a consistent mapping date. Failure to meet this condition can lead to features such as roads and lakes not continuing across adjacent map sheets.
2. **Known and consistent absolute accuracy**—Absolute accuracy refers to the accuracy of X, Y and Z coordinates measured at any point on a map (usually given in feet or meters). Failure to meet this condition reduces confidence, and defensibility of, model results and data analysis.
3. **Known and consistent relative accuracy**—Relative accuracy refers to the accuracy with which features on a map are located with respect to one another (usually measured in distances, angles, and areas). Failure to meet this condition reduces confidence and defensibility of model results and data analysis, and can create problems mapping coincident features for different layers. Inaccurate mapping of coincident features leads to cartographic problems, affects model results, and increases staff and computer requirements during data processing.
4. **Availability of good geospatial control**—Control refers to features that are used to map thematic (land use/cover, soils, etc.) or planimetric layers (roads, property boundaries, etc.) to the base map. Control typically includes a combination of survey monuments, aerial photography targets, and photo-identifiable features such as road intersections, building corners, or fence corners.

5.1.2 Description of 1994 Resolution

Exhibit 5.2 shows the original Base Mapping Resolution discussing the need for a consistent, statewide, digital base map.

5.2 Federal and National Trends

5.2.1 USGS Product Development Outsourcing

A major change in federal mapping development in the last several years has been a move toward outsourcing many functions that once were performed in-house by federal agencies. This particularly affects the U.S. Geological Survey (USGS), the lead federal mapping entity.

The Department of Interior (DOI) houses the USGS. Its National Mapping Division (NMD) has a mission to facilitate mapping nationwide and build and maintain the National Digital Cartographic Database. It pursues this mission by producing data in-house, by contracting for map production through vendors, and through providing funds to assist others who build data to their standards. NMD also provides staff support for the Federal Geographic Data Committee in support of the National Spatial Data Infrastructure initiatives.

Federal legislation has placed the USGS under increased pressure to outsource map production operations. Congress has directed the USGS to meet an aggressive schedule for outsourcing a percentage of its in-house map production operations.

Required Percents of USGS Map Production to Be Completed Through Contracts

Federal Fiscal Year	*Percent*
FY 1996	35 %
FY 1997	50 %
FY 1999	60 %

WHEREAS, as executives of state agencies participating in the use, management, and analysis of human and natural resource data for the state of Texas, we recognize the importance of Digital Orthophoto Quads (DOQs) as the foundation of an accurate, consistent, and up-to-date digital base map for Texas; and

WHEREAS, there is a national program under the U.S. Geological Survey to cost-share the development of DOQs; and

WHEREAS, DOQs serve as a strategic path to developing and updating other digital map layers to highly accurate, consistent, and up-to-date products at a scale which meets the majority of the states needs; and

WHEREAS, need for DOQ production is recognized by federal, state, local governments, and the private sector; and

WHEREAS, Color Infra-Red (CIR) DOQs are an excellent source of detailed information about croplands, forest resources, wetlands, riparian habitats, grasslands, and other vegetative cover; and

WHEREAS, in 1994-5 the U.S. Geological Survey is contracting to acquire CIR aerial photography of Texas east of the 100th Meridian and a similar program is planned for the remainder of Texas in 1996; and

WHEREAS, this photography will serve as an accurate, consistent, and up-to-date source for DOQ production; and

WHEREAS, we the Geographic Information Systems Planning Council, having been duly authorized by Department of Information Resources Charter and directed by executive order of the Governor, have produced plans for coordination and implementation of GIS technologies that rely on the development of consistent high quality base maps;

NOW THEREFORE, we resolve, within budgetary limitations, to pursue acquisition of Color Infra-Red Digital Orthophoto Quarter-quads statewide in Texas and to use these products to help standardize other base map data layers.

The State of Texas is in a unique position to take advantage of this increased requirement for USGS contracting its map production. If the state commits some amount of money to a mapping program that will meet both its and USGS' needs for mapping, there is an opportunity to acquire federal dollars to support the program in a manner similar to the TOP program.

There are no specific requirements on USGS as to whom shall receive these contracts or do the associated work. Texas could choose to do map production either in-house or through (Texas-based) contractors. Using Texas-based contractors would provide the added advantage of promoting economic development in the state.

USGS has a variety of ways to participate in cooperative funding of mapping projects. The mechanism currently in use through the TOP program is a contract mechanism called an Innovative Partnership. The Innovative Partnerships (IP) are a means for USGS to provide cash support to mapping efforts that occur outside its traditional methods of in-house production or direct contracting with vendors. IPs are becoming a more frequently used mechanism at USGS. One very attractive feature of IPs is that USGS can aggregate other federal support through them. This tends to reduce USGS's actual cash commitments, but it increases the amount of money that IP applicants can get access to. Texas has used this mechanism through the TOP program to receive support from two other federal agencies, the Natural Resources Conservation Service and the Farm Services Agency (both within the Department of Agriculture). Each has committed almost a million dollars to the state for the acquisition of digital orthophotography.

Representatives of the U.S. Geological Survey have indicated their willingness to support a follow-on Innovative Partnership proposal for completion of the digital ortho quarter-quads for Texas. The state has also been encouraged by USGS to submit a subsequent Innovative Partnership application to secure additional federal commitments for Digital Line Graph (DLG) production. It is on this basis that StratMap has been proposed (see Section 5.5).

The Department of Agriculture (DOA) houses the Natural Resources Conservation Service (NRCS). The Texas Office of the NRCS is a non-voting member of the Texas GIS Planning Council. It is also cost-sharing participant with the state on the TOP program, and works with state agencies on a broad number of other program as well. NRCS is interested in extending these arrangements to the production of soil survey information for Texas.

5.3 Base Mapping Technological Trends

The optimal way to meet the need for accurate, compatible, digital base maps is for the state to actively acquire 1:12,000 digital orthophoto data. A valuable data layer in itself, this imagery is also a data source for deriving other thematic data layers.

Digital Orthophoto Quarter-quads (DOQs) are produced by taking aerial photography, surface elevation information, and ground control (locational) information, and processing these with a computer to remove distortion (produced by pitch and yaw and changes in altitude of the aircraft, by the curvatures of the camera lens, and by elevation changes over an area). DOQs are sometimes referred to as image-maps because they have the appearance of a photograph, yet have cartographic qualities usually associated with maps. They can be used to accurately measure distances, areas, and angles.

Given their outstanding data qualities, DOQs are one of the data layers needed by most governmental agencies. These up-to-date, rectified, georeferenced raster photo images can provide control to produce and/or update both raster and vector data layers. Though the process of producing DOQs can take 6 to 8 months, the resulting product is much more up-to-date than most existing databases.

The USGS has an active program to develop 1:24,000 digital line graphs (DLGs) from the 1:24,000 analog topographic map series. Unfortunately, given the level of federal funding very little of Texas has been mapped (see Exhibits C.1 through C.7 for the status of USGS DLGs, DEMs, and DOQs for Texas). Further, the digital products are created without updating the existing analog maps. This is problematic as some of these source maps are more than forty-five years old.

To complete Texas DOQ and DEM production and accelerate the development of up-to-date digital vector maps for Texas, the Texas GIS Planning Council has initiated the StratMap proposal. This initiative would produce a number of custodial data layers.

StratMap Base Map Data Layers

Digital Orthophoto Quarter-quads (DOQs)
Digital Line Graph 1:24,000 Transportation
Digital Line Graph 1:24,000 Political Boundaries
Digital Line Graph 1:24,000 Hydrography (water) layer
Digital Line Graph 1:24,000 Hypsography (elevation contours)
Digital Line Graph 1:24,000 Public Land Survey (OTLS will substitute)
Digital Line Graph 1:24,000 Survey and Marker Control
Soil Survey 1:24,000 SURGO *
Digital Elevation Models 1:24,000

* These layers would provide 100% coverage with the exception of the soil surveys which would include 70% coverage by FY 2001.

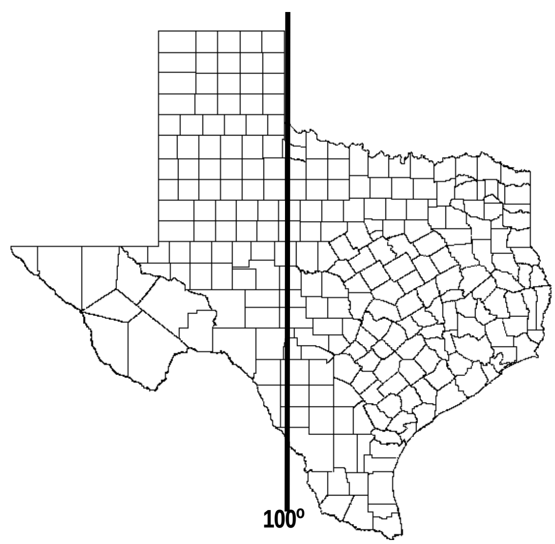
The production of DOQs, DEMs, and DLGs and other digital vector data are presented in greater detail through discussions of the TOP and StratMap programs later in this chapter.

5.4 Specific Accomplishments Since 1994

The major base mapping accomplishments in Texas since 1994 are the completion of the color infrared (CIR) National Aerial Photography Program (NAPP) photography and the use of this photography for the San Antonio-Nueces Data Acquisition Project (SANDAP), for the Transboundary Resources Inventory Program (TRIP), and for the Texas Orthoimagery Program (TOP). All of these projects were undertaken with assistance and partnership of the USGS. In addition, with the impetus of NAFTA and funding from the NRCS and TWDB additional digital line graph (DLG) and digital elevation model (DEM) data has been developed by the USGS for Texas.

5.4.1 National Aerial Photography Program (NAPP)

The USGS in coordination with the National Aerial Photography Program (NAPP) steering Committee has produced 1:40,000 scale color infrared (CIR) photography for Texas during the 1994–1996 time frame. Texas east of the 100th meridian was flown from December 1994 through March 1995. Texas west of the 100th meridian was flown from December 1995 through June 1996. Exhibit 5.3 depicts these two areas.



Acquisition of black and white NAPP photography for the entire nation is scheduled on a seven year repeating cycle. Due to federal funding constraints, not all projects proceed on schedule. To ensure the acquisition of CIR photography for the eastern section of Texas the Council sponsored an effort whereby GISPC state agencies covered the additional costs required to acquire CIR photography. For $157,000, state agencies guaranteed that $894,384 worth of CIR NAPP product was acquired. The western CIR NAPP acquisition required a contribution of $239,000 of State Match Pool money to match federal dollars. This 1:1 match allows Texas state agencies to purchase analog film products from this photography for 50% of the standard USGS price. The indexes and ordering information to purchase USGS photography are available from TNRIS (512/463-8337).

This CIR NAPP initiative is an excellent example of the leveraging of federal dollars with limited state funds. Significant public and private sector benefits will continue to accrue from this program. The film product produced through the NAPP program is being scanned for use as the primary digital input for the DOQ production. The scale, resolution, and accuracy of the resulting imagery are sufficient to make 1:12,000 scale DOQs. The CIR NAPP photography is also valuable in its analog form for resource planners and managers working in Texas in both the public and private sectors.

5.4.2 SANDAP

The San Antonio-Nueces Data Acquisition Project (SANDAP) was initiated by TNRCC to create a base map of the San Antonio-Nueces coastal basin near Corpus Christi. SANDAP utilized DOQs derived from the 1995 NAPP photography of east Texas as the primary data source. Over 300 DOQs were created by the USGS for the project. The SANDAP DOQs were made to USGS specifications and are similar to those being created for TOP. SANDAP has demonstrated the value of DOQs to address a variety of natural and cultural resource mapping and analysis needs. SANDAP showed the value of DOQs and acted as a pilot project for TOP.

5.4.3 TRIP

TRIP was initiated by the Texas General Land Office to coordinate border baseline data development for Texas and other U.S. and Mexico border states and federal agencies in both countries. In the past two years TRIP has served as an important catalyst to the development of Texas base mapping within 100 miles of the Texas/Mexico border. The 1995–96 NAPP photography has provided a source for DOQ base maps which are being developed for this area by the USGS. TRIP and other border resources are discussed in Section 3.3.

5.4.4 The Texas Orthoimagery Program (TOP)

The Texas Orthoimagery Program (TOP) was begun to provide a consistent base map layer from which data may be derived. The program initiated the collection of 1:12,000 digital ortho quarter-quads (DOQs) for the state. TOP was funded through a combination of federal, state, and local money to provide DOQs for about one third of the state. The program received its funding in August 1995 and is expected to run through December 1997.

From its inception, TOP was designed to be funded through a cooperative partnership of federal, state, and local/regional governments. Each level of government, in turn, has many participants. The first contribution to TOP came from the State of Texas. The state contributed $1,415,545 from its state match pool for acquisition of NAPP photography and DEM and DOQ production. State agencies also contributed further by supplying ground control (Texas Department of Transportation), data storage and distribution (Texas Natural Resources Information System, GIS Services (Texas General Land Office and Texas Parks and Wildlife Department), project management (DIR), and advice/analysis through committee participation such as the Council and Managers Committee.

Vendor Selection—The federal government, through the USGS, awarded the Texas Department of Information Resources (DIR) a cooperative agreement for $3,347,510. The agreement allowed DIR to set up and plan the program, select vendors, order materials from USGS, choose areas to cover, and manage the Program. The federal government contributors were the USGS, the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service), and the Consolidated Farms Service Administration (CFSA, formerly the Agricultural Stabilization and Conservation Service). USGS expected this money to pay roughly 50 percent of each DOQ out of an expected minimum of 4626 quarter-quads. A further $300,000 was set aside as an in-kind contribution for USGS products.

Obtaining funds from Texas' many local and regional governments was more challenging because of their numbers. Local governments contributed $1,058,162 to complement the state and federal shares. Contacts were primarily made through the state's Councils of Government (COGs). Texas has twenty-four COGs, each covering several counties. The COGs coordinate local governments and plan development of their regions. Presentations on DOQs to the COGs have been used to spread information about the program. Participants have been informed of the costs ($225 per quarter-quad), the digital products, technical specifications, and questions were answered. Once local funding was obtained, orders were planned and submitted through DIR.

A Request For Information (RFI) was released in July 1995. The RFI described the anticipated program and listed the expected deliverables. Interested groups that were on USGS' list of approved DOQ contractors were invited to submit a proposal to complete the program. Eleven proposals were received by the response dead-line. Members of the Remote Sensing subcommittee of the Managers Committee judged the responses and ranked them by commitment to Texas vendors, ability to develop these data to USGS specifications, production capacity, and quality control planning.

The top five vendors were then asked to submit detailed reports on their proposed plans and present them in Austin. Each vendor made a presentation before the Remote Sensing Group and responded in writing to additional questions asked at the presentations. Scores were recorded during the presentations and a final ranking list was created. After references were checked, the highest rated vendor was extended an invitation to negotiate a contract.

This vendor's program was unique in that the selected vendor would serve only as prime contractor; a large group of subcontractors would create and distribute the products. The DOQs and required DEMs would be created by a group of four subcontractors. Two surveying companies were also included to supplement the Texas Department of Transportation in supplying ground control. In addition, an aerial photography firm was retained for any new photography that may be needed quickly. A final subcontractor is responsible for copying and distributing the DOQs to TOP participants and the general public.

As the DOQs are completed, copies of the data are sent to all contributors, including the USGS where it will become part of the agency's national archival data. The State of Texas, through the work of the GIS Planning Council, is committed to building these products to USGS National Mapping Program standards so they are acceptable as part of the national cartographic database. In addition, all DOQs are considered public domain data, the data can be freely copied and distributed. TNRIS will serve as the Texas public domain archive and clearinghouse for these data sets.

Defining Order Areas, Ordering Source Materials, and DOQ Production—Many resources are required to order and produce DOQs. Once financing is assured through adequate local commitments, materials have to be ordered from the USGS, ground control collected, the DEMs and DOQs produced, and the final product is distributed.

DOQ production is based upon the *Order*. Each order consists of about 300 to 400 DOQs and their associated DEMs. When an order is placed, a number of materials have to be ordered from the USGS. These include NAPP black-and-white photo prints, black-and-white and CIR diapositives (a transparent photographic positive), existing DEMs, camera calibration reports, paper quad maps, and cronopaque hypsography (elevation contour separates from the original quad maps). These materials are known as government furnished materials (GFM). The vender will approve the order and the GFM is ordered. The GFMs are sent to the prime contractor (or appropriate subcontractor) and inspected. Once the GFMs are approved the ground control requirements are specified and the Texas Department of Transportation will collect data using GPS. The completed ground control will then be used with the GFM to create the DOQs and DEMs, where needed.

About one order a month was planned. More frequent ordering could bog down either the vendor or the USGS supply pipeline. Several deadlines were set throughout the production process. These include receipt of GFM, ground control completion, DOQ completion, and delivery of DOQs to contributing agencies. The DOQs are produced in two formats: BIP for federal partners and GeoTIFF for state and local contributor

The prime contractor is required to submit monthly written reports on the status of all orders. DIR uses this information in its quarterly reports to USGS. To keep DOQ users and the public informed of progress, the prime contractor has created an Internet homepage through its distribution subcontractor. The homepage (http://www.txdoqq.com) is being continually updated listing completed DOQs, areas in the works, and future Orders. Sections are also provided for ordering products and submitting questions to the contractors and DIR.

Description of Products—Once the DOQs are produced and in the proper format, a number of data packaging processes take place. First, to aid users in viewing the DOQs, the distribution subcontractor created a simple viewing tool which is placed on all CD-ROMs. This allows viewing with many windows-based PCs without requiring the purchase of additional image processing software. The vendor made several resampled products because the standard 1 meter DOQ uses 154 megabytes of disk storage.

The resampled products allow easier viewing of larger areas by reducing the data storage requirements and also make Internet transfer possible for some products.. The resampled product's pixel sizes are 2.5, 10, and 30 meters. The 2.5 meter product is available only in 8-bit color while the 10 and 30 meter products are in 8- and 24-bit formats. Several CD products are available:

- Four 24-bit, 1 meter quarter-quads forming one quad on a CD-ROM along with the corresponding DEM (base product).
- A 2.5 meter, 8-bit product placing 16 quads (quarter degree) on 1 CD. These smaller images are a good combination of detail and manageable size. These files could be transferred via the Internet, depending on connection speed.
- A 10 meter product in both 8- and 24-bit color. One CD holds the entire Order. The 24-bit product is mosaicked, the 8-bit is not.
- A 30 meter product in both 8- and 24-bit color. One CD per Order. This product was especially useful for examining a multi-county area.

The distribution subcontractor has produced a demo CD with samples of the 1 meter DOQ and the resampled versions listed above. The demo also contains the viewing tool and an order form for duplicate and special order DOQ products. The subcontractor also offers additional services including copies ($45 per CD), data conversions, transfers to tape and other media, data resampling, and hardcopy. The first order was made available in November 1996. Order 1 contains 300 DOQs in the Houston, Texas area.

Data Distribution—The three federal cost-share partners will receive only the standard product (no resampled products) on 8-mm tape instead of CD-ROM. The State of Texas receives copies of all data sets which are sent to the Texas Natural Resources Information System (TNRIS). TNRIS is the state's clearinghouse and referral center for natural resource data. TNRIS will offer many of the same data distribution services the vendor does, including Internet access and data conversions. TNRIS also has a large number of other data sets including U.S. Census data, numerous GIS data layers in different formats, aerial photography, maps and GIS data of Mexico, and USGS quad maps. TNRIS will charge a nominal fee for cost recovery for orders requiring staff and/or computer time or media transfers. The Internet address for TNRIS is http://tnris.twdb.state.tx.us

The demand for DOQ data is expected to be quite large. The vendor will continue to sell the data and market its custom services along with TNRIS and the other program participants. It will be free to set whatever market price it feels is appropriate. Other public and private entities will be able to copy and distribute the DOQs too. The COGs will receive copies for distribution to their regional entities.

The Texas Orthoimagery Program was conceived by the Council as the best solution for implementing a statewide raster base map. TOP is being carried out through an innovative partnership grant from the USGS. Joining the federal grant is a state grant and contributions from numerous local and regional entities. This multi-level government partnership is providing an accurate, up-to-date, and consistent base map that would have been impossible without this cooperation. The injection of $1,415,545 of Texas State Match Pool money combined with $1,058,162 of local money has allowed Texas to leverage $3,647,510 in federal money to produce DOQs for Texas as well as the CIR aerial photography and DEMs required to develop the DOQs.

5.4.5 DLGs and DEMs

The digital line graphs and digital elevation models described in Appendix C have been traditional sources of digital base maps provided by the USGS. The status of these products for Texas is shown in Exhibits C.1 through C.6. Incremental progress has been made over the last two years with input from state and federal sources. The greatest increase in availability of these data layers has been the addition of DEM data associated with border data development and DOQ production. The Texas Water Development Board provided $20,000 in FY 95 to the USGS to develop DLGs and DEMs. This money was matched 1:1 by the USGS. In FY 96 TWDB funding was used to develop DEMs and DOQs in the Laredo border region.

5.5 Future Plans

The goals of of the Base Mapping initiative are:
1. Complete the acquisition of 1:12,000 DOQs and 1:24,000 DEMs for Texas,
2. Provide a funding pool for the development of USGS digital line graph data layers such as transportation and hydrology, and
3. Where feasible, develop these products in partnership which allows local and regional entities to develop larger scale data layers.

When the 1994 Implementation Plan was written DOQs were one of the four main initiatives featured under the Base Map Development Resolution (Exhibit 5.2). Since this resolution Texas has made great progress towards developing statewide DOQs. However, to complete the statewide DOQ and DEM acquisition and to complete vector digital line graph (DLG) mapping and make significant progress towards statewide soils (the Soil Survey Geographic Database - SSURGO) mapping an initiative called StratMap is being undertaken (see Exhibit 5.4).

The Data Acquisition Committee of the Council will work with Texas custodial agencies as well as federal and local partners to determine how best to implement the StratMap proposal to build framework Texas data sets. Products such as DOQs and DEMs already under development through TOP will be completed through StratMap and will assist with the development of other statewide data layers. The exact procedures and specifications to be used are yet to be determined.

5.5.1 StratMap

To accomplish statewide digital data layers, we recommend the StratMap Initiative. StratMap calls for establishing a Texas-based cost-sharing program to develop digital geographic data layers in partnership with other public/private sector entities. It is designed to minimize individual participant costs, build the most accurate and up-to-date base maps feasible, and place them in readily accessible formats, in the public domain. By funding StratMap, the legislature will set in place a program that provides an aggregate solution to multiple needs.

The goals of StratMap are:
1. Complete the acquisition of 1:12,000 DOQs and 1:24,000 DEMs for Texas,
2. Provide a funding pool for the development of USGS digital line graph data layers such as transportation and hydrology, and
3. Where feasible, develop these products in partnership which allows local and regional entities to develop larger scale data layers.

Like TOP, all data produced through StratMap will be placed in the public domain so that the data may reach as many users as possible.

WHEREAS, as executives of state agencies participating in the use, management, and analysis of human and natural resource data for the state of Texas, we recognize the importance of the StratMap initiative to develop large scale digital orthoimagery, digital elevation models, digital line graphs and soils maps as critical components of the digital Texas base map; and

WHEREAS, there is a national program under the USGS to produce large scale DOQs, DEMs, and DLGs and to cost share the development of these products; and

WHEREAS, there is a national program under the Natural Resources Conservation Service to develop large scale digital soils maps and to cost share the development of these products; and

WHEREAS, need for the above digital map products is recognized by federal, state, local governments, and the private sector; and

WHEREAS, these products can be used to produce other digital map thematic map data which since derived from up-to-date, accurate, consistent sources will also be up-to-date, accurate, consistent in scale, and;

WHEREAS, we the Geographic Information Systems Planning Council, having been duly authorized by Department of Information Resources Charter and directed by executive order of the Governor, have produced plans for coordination and implementation of GIS technologies that rely on the development of consistent, high quality base maps;

NOW THEREFORE, we resolve, within budgetary limitations, to pursue acquisition of large scale CIR DOQs, DEMs, DLGs, and soils digital base maps statewide in Texas and to use these products to help standardize other thematic digital data layers.

The Council has been working for several years to build an environment where agencies in Texas work together cooperatively to develop and share digital data layers and promote public access. This vision is unique in that it supports a coordinated systematic approach to the deploy-ment of technology across all governmental functions. By funding StratMap, the Legislature will help formalize this vision and help maximize its benefits to the state. As a result, Texas will become more efficient, more effective, and better equipped to meet the challenges of the future.

In FY 1996, the Council on Competitive Government (CCG) worked with DIR, the General Land Office, and other members of the Council to study the deployment of GIS technology in the state. One of the products of this study was CCG's support for a DIR application to the Texas State Match Pool Pilot program to establish the Texas Orthoimagery Program (TOP) data acquisition effort. With the award, DIR, as an agent of the Council, was able to secure federal commitments for more than twice that amount—$1.4 million from the state brought in $2.9 million from the federal government. With these commitments in hand, DIR was able to secure regional commitments that resulted in a better than 3:1 match of state dollars. Products from TOP are being distributed to all cost-sharing partners and are readily available in the public domain.

StratMap will replicate the mechanisms used in TOP to leverage $27 million from a $10 million state investment. With these commitments in hand, the Texas Water Development Board (TWDB), acting on behalf of the state, and with guidance from the Council, will secure arrangements with federal counterparts to either fund complete data layers, or at least, to acquire commitments to cover 75% of the funds needed to develop each data layer. Then, if necessary, regional sponsors will be solicited to cover the remaining 25%. Data layers will be developed, primarily through Texas-based vendors. Products will be delivered to cost-sharing partners and distributed through state and regional data sharing networks.

StratMap Program Management and Operation—The Texas Water Development Board (TWDB) has been identified as the lead agency for the StratMap program because of both its legislative mandate to perform topographic mapping, and its extensive data distribution capabilities. TWDB will use StratMap funds to attract federal partners to contribute approximately $20 million over the life of the project. The combined total of federal and state funds ($30 million) will be used to attract other partners on a region by region basis. Approximately 25% of the cost for data development for any given region will be covered by the state, 50% by federal sources, and 25% by regional or local sponsors.

The program will take four years with a phased-in delivery of products. Data will be developed based on participation of regional/local sponsors. Every effort to work through regional coordinating councils such as Councils of Governments and Resource Conservation and Development areas will be made.

Data Production Objectives—StratMap calls for a four-year program for statewide acquisition of four types of digital products. These include Digital Orthoimagery, Digital Elevation Models, Digital Line Graphs, and Soil Surveys. The data layers are described in 5.6 Benefits. The production objectives for these data layers follow.

Product Development Objectives

Product	***Objective***
Digital Orthoimagery	Complete a statewide coverage of digital 1:12,000 scale orthophotos which started with the TOP program.
Digital Elevation Models	Complete the 1:24,000 scale DEMs for the state as an essential step in digital orthoimagery production.
Digital Line Graphs	Complete the 1:24,000 scale DLGs for the state. Several individual data themes (or layers) found on the USGS quad maps will be updated and digitized as a separate data layer.
Soil Surveys	The Natural Resources Conservation Service (NRCS), a division of the U.S. Department of Agriculture, is proposing to cost-share the digitization of 150 1:24,000 scale county soil surveys in the State of Texas through the StratMap program.

StratMap Product Requirements—Acquisition of these data layers will involve contractual arrangements between and among participating agencies. Contracts will be developed insuring that all products will be current and accurate at the scale of production according to national standards, and documented according to consistent national standards.

Additional StratMap Program Objectives—Additional objectives of the program include: matching every state dollar with at least 2.5 dollars from other sources (to result in at least 3.5 dollars of product), spending at least 60% of program dollars through Texas-based vendors, extracting residual value from expenditures that the state has already made in production of digital products by using those products, retaining working relationships between program participants to facilitate ongoing collaboration, and providing training to Texas GIS practitioners in the use, manipulation, cataloging, and retrieval of these products.

StratMap Personnel Requirements—Current expectations are that StratMap will require the addition of four full-time employees: a State Cartographer to manage the overall program, a Match Pool Coordinator to manage financial matters, a Quality Manager to ensure cartographic and other appropriate standards are met, and a Partnership Manager to facilitate partnership arrangements.

The position of State Cartographer should be maintained as a permanent position to maximize the benefits of this program over time and to coordinate subsequent mapping projects. The other three positions will be temporary. They may be extended beyond StratMap if adequate external funding is available.

5.6 Benefits

For many years, Texans have relied on the U.S. Geological Survey (USGS) paper maps to locate themselves, their properties, and resources and to plan and manage these resources. Many of these maps are 20 to 40 years out of date. Now, Geographic Information System (GIS) users are faced with the problem of creating digital base map data layers. StratMap will build mission-critical digital base maps statewide. This information will document the land (soils, elevations, survey control), water, transportation infrastructure, and social patterns (the original land surveys and political boundaries). Copies of this information will be provided to all cost-sharing partners, and broadly distributed in the public domain. In addition to helping individual agencies do their jobs, sharing this information will help them to avoid significant duplication of effort and to work together better.

These data layers are a basic need of state agencies. When available they will provide a common frame of reference for activity throughout the state. These activities include planning for future water resources, monitoring of wetlands and sensitive habitats, identifying historical and archaeological features, determining land use, and locating hazardous waste facilities, as well as oil and gas wells, pipelines, and other energy related facilities.

The Texas Attorney General's Office has estimated that the 1990 Census undercount of Texans cost the state more than $241.8 billion in lost federal funds during the decade of the nineties. With the current move to provide more federal dollars to states through block grants to promote state run social programs, the potential exists for even higher dollar losses during the next decade. StratMap can help ensure this does not happen.

StratMap will build information that is mission-critical to Texas. It will do this through a cost sharing program in which the majority of the cost will be borne by entities other than the state. Products will be broadly available to the public. Future digital data acquisition programs will be a matter of updating existing information rather than creation of original material. The fact that the StratMap products will be used by private industry as well as government, will smooth the interactions these two sectors and generally improve the economic development climate in Texas. The resulting alignment of information and decision making systems among participating entities will provide more efficient and effective government, and provide source material for a variety of value added activities in the private sector.

6.0 Global Positioning System Initiative

Due to its low cost and a highly accurate method of determining location, Global Positioning System (GPS) technology is becoming increasingly important in building and maintaining Geographic Information Systems. Accurate locational data is essential to a successful GIS, especially when used for natural resource planning, pollution analysis, oil spill response, facilities management and regulation, surveying, and many other primary functions of state government.

Interagency coordination and standardization in the use of this technology can play a major role in building effective GIS databases for all GPS users in the state. By standardizing GPS use, agencies will be able to apply this technology quickly and cost-effectively.

In building a statewide GIS, GPS technology will enable the state to verify/correct historical data and to collect/ process more accurate information. Data conversion and capture can represent 80% of the cost of building a com-plete GIS. This is due to the amount of time required to convert hardcopy maps and data into a digital format and gather new information. GPS represents a low-cost, higher-accuracy alternative to traditional methods for gathering information in the field.

6.1 Description of the 1994 Resolution

The state would benefit by coordinating the use of GPS technologies in the following areas:

- implement a statewide network for the real time broadcast of GPS correction data
- standardize the implementation of GPS technology within state agencies to ensure that data is captured in a consistent, cost-effective manner.

Exhibit 6.1 shows the Field Data Collection Resolution passed by the Council on November 22, 1994.

WHEREAS, as executives of state agencies participating in the use, management, and analysis of human and natural resource data for the State of Texas, we recognize that accurate locational data is essential to GIS operations and that Global Positioning System (GPS) technology is the most appropriate tool for acquiring the locational information the state needs in the field; and

WHEREAS, many different agencies are implementing GPS technology as field data collectors to aid in capturing new facility and natural and cultural resource data to be included in GIS databases; and

WHEREAS, the current methodology for obtaining accurate GPS data requires significant resources for post-processing of information, and is cumbersome, costly, and time-consuming; and

WHEREAS, there are significant savings to be realized through the broadcast of real- time GPS correctional information; and

WHEREAS, there are a variety of real time technologies available in the marketplace that can provide the State of Texas with statewide service to improve the accuracy and reliability of facility and natural resource locational data; and

WHEREAS, we will continue to monitor studies and reports from the federal government on the use of real time broadcast of correctional data to enhance GPS capabilities to clarify the choice of the most appropriate technology for real time GPS broadcast; and

WHEREAS, we the Geographic Information Systems Plan-ning Council, having been duly authorized by Department of Information Resources Charter and directed by executive order of the Governor, have produced statewide plans for coordina-tion and implementation of GIS and GIS-related technologies that require consistent and accurate field information;

NOW THEREFORE, we resolve to work in partnership with federal and local government to standardize the use of Global Positioning Systems (GPS) and to pursue means to economically develop a real-time GPS correctional data broadcast network for use by state agencies that have a need for low cost, efficient GIS field data collection.

Standard Implementation of GPS Technology—While there are numerous state agencies already making beneficial use of GPS technology, some agencies are just begin-ning to realize the potential of GPS for both engineering and GIS-related applications. In order to ensure that GPS is implemented in a cost-effective, consistent manner, it is important to develop standardized metho-dologies and capabilities that all agencies can reference in building their applications. Experienced users within state agencies and GPS experts in government as well as the private sector need to be consulted as the state develops its GPS infrastructure. This will provide an environment in which costs can be minimized and data collected with GPS will be consistent and compatible.

The use of GPS provides a common geo-referencing system for a variety of engineering and mapping appli-cations. It also can play an integral part in the develop-ment of aerial photography and digital imagery. Texas' existing GPS infrastructure is currently based on TxDOT's Regional Reference Points and the system of control points that TxDOT has put in place over the years. These control points are extremely accurate and have been registered with the National Geodetic Survey. This system represents the backbone for capturing accurate GPS locational data.

The significant knowledge and expertise developed within TxDOT's organization while developing their system has been an invaluable resource in the education of other GPS users as agencies have adopted this tech-nology. The continued education of agency personnel will be important in ensuring that the state takes advan-tage of its existing infrastructure, minimizes future costs, and proceeds with GPS implementation in an standardized way.

6.2 Federal and National Trends

Several federal agencies have shown great interest in implementing GPS technology for a variety of purposes. The Department of Defense (DoD) is the largest current user in the federal government, but agencies within the Department of Commerce (DOC) and the Department of Transportation (DOT) have also initiated efforts to implement GPS. Two of the primary uses seen by these agencies are for aviation support and for traffic control. The Federal Aviation Administration (FAA) has con-ducted pilot studies and has begun localized implementations of GPS technology for assisted navigation during takeoffs and landings. They see GPS technology as a revolutionary tool for air traffic control. The Department of Transportation has studied several aspects of GPS technology in order to support an Intelligent Vehicle Highway System (IVHS). An IVHS would rely on GPS to help monitor the nation's most congested freeways and provide input to a new traffic control system.

The U.S. Coast Guard, which is part of the USDOT, has already established a very successful system in conjunc-tion with the U.S. Army Corp of Engineers that is used for maritime traffic and navigation on the nation's coasts and navigable waterways. This system is based on the real-time broadcast of Differential GPS (DGPS) data via radio beacons and provides corrections to GPS data, making it possible to capture locations as accurate as two meters. DGPS is almost complete along the nation's coastal borders and the river portion is being expanded. See Exhibit 6.2 for the locations of the current DGPS sites. Surveyors, the land transportation industry, geo-scientists, and meteorologists are taking advantage of these signals in inland areas where possible. This includes states, or portions of states, along the Missis-sippi River, the Gulf of Mexico, the Great Lakes region, and the nation's eastern and western shorelines.

The U.S. DOT is the designated agency charged with representing the nation's civilian interests in the use of DGPS, and has begun studies to determine the interest and feasibility of extending the Coast Guard's DGPS system. The Federal Highway Administration is leading this effort and is currently conducting the necessary studies to determine issues such as implementation, ownership, maintenance, and liability. Other federal agencies including the U.S. Coast Guard, National Oceanic and Atmospheric Administration, and the Federal Rail Administration have received inquiries about possible expansion. It is estimated that approxi-mately 20 additional sites would complete the coverage of the 48 contiguous states.

Two of these marine beacon transmission stations have been established in Texas, and represent a free resource for use by state agencies and the public. The range of the low-frequency DGPS signal varies, but is generally being received within 200 to 250 miles of the beacon sites. The expansion of this system, using the same or similar technology would provide a consistent means of capturing accurate data for a variety of purposes. State cooperation with the federal government in the establishment of a GPS infrastructure will serve to benefit both the public sector and the private sector. Cooperative programs and standardized implemen-tations of GPS technology which

Exhibit 6.2 DGPS Coverage Not Available

allow the various government entities to share costs and methodologies will serve to improve the efficient acquisition of geospatial data. Two examples of the benefits to the private sector of this expansion are detailed below.

6.2.1 Positive Train Control

The Federal Rail Administration (FRA), in its June 1995 report "Differential GPS: An Aid to Positive Train Control," submitted to the Committees on Appropria-tions, is supporting the use of Differential GPS as "a means of promoting the accuracy and utility of positive train control systems." Positive train control systems are technologies which aid in preventing collisions between trains, deter the possibility of high speed derailments, and can provide additional safety and economic benefits. Not only does this expanded technology repre-sent a major aid in the prevention of accidents and casualties (approximately $35 million per year in losses), but it also would provide better quality service, more efficient utilization of existing track, and reduced fuel consumption through better pacing of trains. The FRA report cites that "over the past several decades, the energy efficiency and congestion mitigation potential of railroad transportation has significantly increased the demand for and use of the railroad infrastructure of the United States." The railroad industry's ability to imple-ment new technology will depend on the public expansion of the DGPS network in order to quickly take advantage of these potential benefits.

6.2.2 Precision Agriculture

The U.S. Department of Agriculture has been actively supporting a new revolution in farming operations that provides the ability to plant, fertilize, and harvest in such a way to provide economic benefits, and with respect to the ecology of the land. The potential benefit of applying exact amounts of chemicals for the greatest gain in productivity, and minimization of the chemical effect and cost, could possibly represent the greatest technological change to impact farming in 100 years. Most of the states with significant farming interests such as Illinois, Kansas, Indiana, Missouri, Oklahoma, Minnesota, Michigan, Wisconsin, Nebraska, Iowa, and the U.S. shoreline states, all have adequate DGPS signal availability. This capability speeds their ability to take advantage of precision farming and realize the economical and ecological benefits of these new techniques. However, the availability of Differential GPS is a problem for many of the other high dollar grain crop producing states such as Texas, which has less than one-third of its area covered by DGPS correction signals. It is feared that without expanded coverage of DGPS, states without access will fall behind in technology and profitability, making it harder for them to compete with other agribusiness entities.

6.3 Global Positioning Systems Technological Trends

Currently there are numerous state agencies using GPS receivers to gather GIS locational data and perform surveying tasks. Many of these agencies are using real-time differential correction to provide extremely accurate positioning as the data is collected in the field. A variety of techniques to acquire real-time corrections have been tested, and this has provided additional insight into the advantages and disadvantages of each real-time capability. Exhibit 6.3 gives a description of the common methods for real-time correction. For a more basic description of GPS technology and its use, see Appendix D.

Agencies using GPS include the Texas Department of Transportation, the Texas Parks and Wildlife Department, the Railroad Commission of Texas, the Texas Natural Resource Conservation Commission, the Texas Water Development Board, and various university departments such as the University of Texas Bureau of Economic Geology. These agencies are using their receivers primarily to collect information for their GIS databases.

Applications of GPS include verifying and obtaining locations of the following:

- oil and gas wells
- public drinking water sources
- hazardous waste facilities
- hydrographic surveying sites
- sampling sites for geologic and hydrologic studies
- sampling sites for use in classifying imagery
- ground control for aerial photos
- endangered species habitats
- water sources for wildlife
- pipelines and related facilities
- centerline roadway data

6.3.1 Real-Time GPS Broadcast Usage and Trends

Many of the agencies participating on the GPS Coordination Committee have been involved in traditional data capture of GPS locational information for several years. The need to improve on these traditional data capture methodologies was the stimulus for creating the GPS Coordination Committee. Working together closely to research and test real-time broadcast possibilities, state agencies have determined that this methodology is the preferred means of gathering GPS points for inclusion in geographic information systems because it requires less time spent for data collection and no post processing for differential corrections.

Members of the GPS Coordination Committee have been utilizing the four data capture alternatives presented in Exhibit 6.3 in order to determine the best way to provide the state with a real-time broadcast network for GPS differential correction. Satellite communications, FM radio sideband signals, cellular communications and radio beacon broadcast have all been analyzed to determine a cost-effective and reliable option which satisfies agencies' requirements. Multiple projects have been performed in carrying out agency requirements which have helped in determining costs and identifying advantages and disadvantages. Because of its consistent and reliable performance and due to the previous efforts of the U.S. Coast Guard, the radio beacon transmission option is regarded as the best opportunity for statewide coverage in the near future.

Establishment of a real-time broadcast network to provide differential correction of GPS positioning data in the field would allow for a more efficient means of collecting valuable data needed for developing base maps and specialized spatial data. The time savings of this method compared to the post-processing method would provide significant cost savings to the state in terms of staff and resource allocation since post-processing of large amounts of data requires significant computer and personnel resources. Real-time broadcast eliminates the need for this post-processing step, allowing the state to redirect resources to other tasks. The development of a real-time broadcast network by the state would provide a valuable resource to state agencies and would also provide a public service for use by other local governments as well as members of the private sector and the general public.

6.3.2 Other GPS Technological Trends

There are two technology issues that will affect the use of GPS technology over the next two to four years that are worth mentioning here. Both of these upcoming trends will serve to enhance the use of GPS receivers when collecting data. The first issue is the possibility that the federal government will turn off Selective Availability (S/A), which is used to diminish the accuracy of the GPS satellite signals received by the civilian users. The second issue is the apparent willingness of GPS vendors to incorporate real-time broadcast capabilities into their standard GPS receiver offerings.

Selective Availability—The Department of Defense (DoD) is the operator of the GPS satellite constellation and continues to intentionally distort the satellite signal accuracy for national security reasons. While the military users are receiving 10 to 20 meter accuracy, other users can expect a wide range of accuracy from 30 to 100 meters on average depending on the quality of equipment used. However, the DoD has been getting pressure to turn off S/A, and has tentatively agreed to remove this distortion mechanism by the year 2000. While the removal of S/A will provide more civilian users with reasonable accuracy, there is still a fairly wide range of resolution which depends on the quality and the number of channels of the GPS receiver being used. Most of the natural resource agencies, along with transportation and public safety interests, will still have a need for consistently greater accuracies of under 5 meters. In other words, a real-time differential correction system will still be needed.

GPS Products—Another trend that is affecting the use of GPS is the commitment from GPS vendors to support the U.S. Coast Guard's Radio Beacon System by including beacon receivers as part of their standard GPS equipment. New GPS receiver models are being made available that have one antennae which can capture both the GPS satellite signal as well as the radio beacon signal. The receiver then performs the correction of the signal in real-time, providing for greater accuracy in the field. While this capability is not totally new, the inclusion of the radio beacon receiver as part of the standard offering is getting to be more common and more economical as overall pricing for GPS technology continues to drop. This configuration also means that the equipment needed to capture differential corrections will become less bulky and easier to manipulate when in the field. This is extremely good news for state agencies that typically have limited dollars to spend in outfitting hundreds of field inspectors, engineers, law enforcement officials, and technicians across the state. This will become even more important, and more common, should the state be able to extend the Coast Guard beacon network.

1. **Satellite Communications**—Commercial, satellite-based real time broadcast of corrections is available statewide and provides sub-meter accuracy. Members of the GPS Coordination Committee consider this option a viable solution but have experienced some loss of signal working in canopied areas with dense vegetation. Cost of this option is significant, but dropping. Users of this system must purchase additional equipment and also lease the satellite service on an ongoing basis.

2. **Radio Beacon Broadcast**—The U.S. Coast Guard and the Army Corp of Engineers have developed a network of radio beacons along the U.S. coastline and up the major inland waterways to provide safe and accurate navigation for commercial shipping interests. The system uses base stations and transmission towers for direct radio broadcast of low frequency correction signals. There are currently two radio beacon transmitters in place on the Texas Coast, one in Galveston and the other in Aransas Pass. The beacon signals are a public service and therefore are free to anyone with a beacon receiver. The range varies according to area, but is generally good to 200 to 250 miles. Signal reception is affected by stormy weather but has proven to be superior in foliage. This method of real-time GPS is proven and reliable from both a technical and economic standpoint, but the coverage is limited to beacon areas.

3. **FM Radio Sideband**— This commercial system uses a sideband from an FM radio frequency to broadcast correction signals to digital pager-like receivers that interface with GPS receivers. There are two companies currently operating systems in Texas that rely on the FM radio sideband method. Neither offers statewide coverage and provide correction signals primarily in metropolitan areas. This method of distributing correction signals has become more viable, but there are limitations in signal broadcast (30 miles in range is typical). Reliable signal areas tend to center around urban areas, leaving rural areas bare. The DGPS receiver is fairly inexpensive, but a yearly subscription rate is charged for signal service.

4. **Cellular Communications—**Cellular phones equipped with modems could be used to deliver real-time broadcast of GPS correction data. Although simple to implement, this method is costly given the current pricing of cellular communications. The general public could be given access to this type of system.

6.4 Specific Accomplishments Since 1994

The state has continued to make progress toward the goals identified in the November 1994 GIS Implementation Plan regarding the GPS initiative. Use of GPS as a utility for collecting GIS data has increased significantly, and cooperation among state agencies to educate users on GPS technology has continued to improve. The state's initiative to create a real-time broadcast network of differential GPS corrections has also shown significant promise. The following items represent specific accomplishments toward the increased use of this technology.

6.4.1 GPS Vendors on State Catalog

GPS vendors, with very few exceptions, have made their products available on the General Services Commission's state catalog system at reduced prices. This has allowed the state agencies to take advantage of increased use of GPS products and services at reasonable prices. Information delivered to vendors regarding state agency demand for GPS products has helped to increase the number of vendors offering GPS products in Texas, and has helped to ensure that Texas state agencies have the opportunity to purchase discounted products whenever possible.

6.4.2 Increased Use of TxDOT's Regional Reference Point Data

Over the last two years, TxDOT has made it easier for agencies to utilize its data collected at the Regional Reference Point (RRP) sites around the state. The RRP sites are a statewide network of GPS base stations which collect highly accurate GPS control data. Statewide access to this geo-referencing network has served to form the nucleus of the state's GPS infrastructure. TxDOT is currently offering several months of up-to-date GPS control information on the agency's World Wide Web site, making it easier to select and gather the specific files needed for post-processing of GPS point data.

For areas in the state where there is no real-time differential correction available, or in instances when extremely accurate, sub-meter point data is required, the RRPs have proven to be the best alternative for capturing location data. Now with easy access to this information, once a GPS user has collected point data in the field, they can easily extract the corresponding base station data from the appropriate RRP and download this data to their computer for processing. This service is being provided by TxDOT as part of its other WWW offerings, and has made it much more efficient to perform the tedious process of correcting GPS points via post-processing.

6.4.3 Increased Level of GPS Knowledge and Expertise at State Agencies

Interagency sharing of information and expertise has helped establish a broad range of knowledge within the state to aid in the implementation of GPS. Numerous agencies have begun to take full advantage of GPS in collecting and building GIS data layers. GPS is a challenging technology and agencies have been able to benefit greatly from each other's experiences.

6.4.4 Progress Toward Development of Real-Time Broadcast Network

Members of the GPS Coordination Committee have worked to continuously monitor the activities at the federal level related to real-time broadcast of differential corrections. Agency staff members have developed contacts in a variety of federal agencies that have helped the state promote its desire to see the U.S. Coast Guard's network of beacon transmitters expanded in Texas. To help promote these efforts at the federal level, the GIS Planning Council's Texas Mexico Border Region/TRIP Liaison committee sent a letter to the Secretary of the Interior in April of 1996 which included a recommendation for the expansion of the Differential GPS network. The expansion of this network would help provide consistent and uniform data collection along the Texas/Mexico border, and would provide a more efficient means of collecting valuable data needed for developing base maps and specialized spatial data.

GPS experts at the state level have also worked with the GPS vendor community to further research and test means of transmitting real-time differential corrections, and have pursued this testing as part of ongoing agency activities. Increased networking and sharing of information between agencies, and between agencies and the vendor community has allowed agency staff to take full advantage of the Coast Guard beacon transmitters that exist along the Texas Gulf Coast, and the recently installed beacon transmission site in Salisaw, Oklahoma near Tulsa. This site has allowed the state to take advantage of beacon transmission signals in North East Texas when collecting data for projects in that area.

Beacon Transmitter Network of Texas—GPS Coordination Committee members have recently been concentrating on the development of strategies for setting up new beacon transmitter sites in Texas. Even though the federal government has continued to discuss the expansion of the Coast Guard DGPS network, no additional sites in Texas are planned in the near future, so the state has become more determined to set up its own Beacon Transmitter Network of Texas (BTNT). This network would be compatible with the existing Coast Guard Beacons and would serve to fill in the gaps not currently covered, specifically targeting the Central and West Texas areas. The strategies necessary to create the BTNT were identified by the group as follows:

- Identify and prioritize targeted areas for coverage;
- Determine costs for equipping a site;
- Identify alternatives for site development in Texas;
- Identify available in-kind contributions for site development including equipment and/or existing towers that could be equipped for beacon transmission.

The BTNT team has been working through these strategies and has recently made significant progress toward setting up an additional beacon site in Texas.

Targeted Areas of Coverage—The BTNT team has determined that an additional 3–5 sites will be needed to provide complete beacon coverage for Texas. This may include coverage from site development in neighboring states such as the beacon transmitter placed near Tulsa, Oklahoma early in 1996. Exhibit 6.4 shows the current DGPS low frequency radio beacon coverage areas in Texas. Sites in Central Texas, the Panhandle, and West Texas would provide the state with approximately 85 percent coverage. If a site were to be developed in New Mexico, Louisiana, or near El Paso along the Texas/Mexico border region, the state would then have complete beacon coverage. The BTNT team has targeted first Central Texas and then the Panhandle area as high priority coverage needs, with the West Texas area planned for inclusion as soon as possible.

Costs of Beacon Site Development—Items necessary for beacon site development include land acquisition, installation of ground plane, installation of antennas and towers, a small building to house electronic components, installation of GPS reference stations along with stable platforms for housing, low frequency transmitter, and assorted cabling and electrical installations. The cost for a site is approximately $100,000 for equipment. There could be additional land and construction costs of about $50,000 to develop a new site. Retrofitting of an existing site could cut down the costs significantly, possibly to as little as $35,000 to $50,000.

Alternatives for Beacon Site Development—The BTNT team has identified four likely alternatives for further beacon site development in Texas (Exhibit 6.5). These alternatives cover a range of scenarios, each with different technical issues and costs associated.

In-Kind Contributions—In-kind contributions of equipment, funding, and/or existing tower sites can significantly reduce the cost of developing a beacon transmitter site. Finding an existing tower site could be the most important development issue due to the significant costs involved in acquiring and outfitting a suitable piece of land for the site. Both state agencies and the vendor community should be prepared to offer in-kind contributions in order to ensure that development of the BTNT can proceed.

To date, Texas Parks and Wildlife Department, Texas Department of Transportation, and Starlink Incorporated, a local GPS equipment manufacturer, have each identified potential in-kind contributions that could be made available for inclusion in a beacon transmitter site. TPWD has identified an existing tower location in the Temple area of Central Texas that could potentially be retrofitted for use in the BTNT. TxDOT has possibly identified an existing, high quality Ashtech GPS receiver that could be upgraded to the appropriate capacity for inclusion in the BTNT, and Starlink has agreed to provide a refurbished radio transmitter for the site. Starlink has also agreed to help work through the necessary bureaucracy at the federal level to apply for and secure an appropriate FCC frequency for transmission from the site. The license required to

broadcast will be a 2-year temporary license that will be used in part for DGPS equipment testing and research to be conducted by Starlink. Rockwell International, which is part of the team hired by the FHWA to develop plans for USDOT expansion of the Coast Guard's DGPS network, has also helped the state's GPS Coordination team with its recent expansion plans. Rockwell has helped identify contacts at the federal level, and is working to include Texas' needs in the federal plans. These federal implementation plans will encourage state/federal partnerships.

Temple BTNT Site—Working through these identified strategies has allowed the team to realize significant progress toward setting up the first new Texas beacon site. The TPWD tower in Temple is being evaluated and retrofitted to allow for transmission of radio beacon differential corrections. The additional in-kind contributions of equipment and services identified above, along with small amounts of funding from the state agencies, could allow the state to set up the Temple site as a pilot site within the next few months. This site would be outfitted to comply with all known U.S. Coast Guard operating standards so that it could be included in the USCG network at some point in the future.

Scenario 1—Complete development of site funded by Texas state consortium.

This option would require that the state find a suitable piece of land either already owned by the state, or appropriate to purchase. It would also require that the state agencies come up with the funding required for outfitting of the site which if built from scratch, is estimated to be between $100,000 to $150,000 not counting possib land costs.

Scenario 2— Agreement for use of decommissioned U.S. Air Force low frequency site.

This option would utilize the U.S. Air Force's (USAF) Ground Wave Emergency Network (GWEN), which is a low frequency communications network for the strategic nuclear forces within the USAF. These sites are being considered for decommission after 1998, and could potentially be modified for DGPS use. These sites would be extremely advantageous because it would eliminate the land and installation costs required in developing a new site. The GWEN sites also would already be equipped with ground plane, antennas, and housing for equipment. It is estimated that modification of a GWEN site would cost less than $100,000. In Texas, GWEN sites exist in the Panhandle and the West Texas are

Scenario 3— Agreement for use of retrofitted Texas owned anc operated tower site.

Texas state agencies operate numerous radio antennae towers throughout the state to support communications by law enforcemen field engineers, and local police authorities among others. Some of these towers could potentially be retrofitted with a transmitter and GPS receiver so that they could support DGPS in addition to their current functionality. Costs of this option could be as little as $35,00 to $50,000 depending on the quality and type of existing installation

Scenario 4— State partnership with federally funded initiative (USDOT).

The FHWA initiative to draft an implementation plan for extending th USCG Low Frequency beacon network to cover the rest of the 48 contiguous states does have a provision for both state/federal partnerships and for government/private partnerships. These issues are being researched and have not yet been finalized. At present, there is no federal funding identified for extending the U.S. Coast Guard network. There is the potential for funding to be appropriated in 1998, which could coincide with the release of the GWEN sites fo use in the network.

6.5 Field Data Collection Future Plans

There are four objectives for FY 1998–1999 activities related to the field data collection initiative:

1. Completion of the first Beacon Transmitter Network of Texas site in Temple,
2. Increased coordination between Texas and the federal government regarding GPS expansion,
3. Further expansion of the BTNT to cover up to 90% of the state, and
4. Further development of GPS standards and guidelines for state agency users.

The major focus of the Global Positioning System initiative for FY 1998–99 will continue to be centered on creating a statewide real-time broadcast network for differential corrections. This network should be patterned after the U.S. Coast Guard's DGPS network, and every effort should be made to work with the federal government in creating the network. Until federal monies are made available to create additional beacon transmission sites in Texas, the state organizations, working in conjunction with the private sector, will pursue a variety of strategies aimed at creating the Beacon Transmitter Network of Texas (BTNT). After the first BTNT site is installed, the goal of the GPS Coordination Committee members leading this effort will be to implement 2 to 3 additional beacon sites in Texas during the 1998–99 biennium. These sites will be targeted for the West Texas area where there is currently no beacon coverage available.

6.5.1 Completion of First BTNT Site in Temple

Significant progress has been made during the early part of fiscal year 1997 to create a beacon transmitter site near Temple, Texas. This site will be located at an existing TPWD communications tower installation, and will be retrofitted to allow for GPS beacon transmission on a not-to-interfere basis. The GPS team will work closely with the TPWD staff manning this site to ensure that there will be no adverse effect on existing communications functions. Development of the site near Temple, along with the existing Coast Guard sites, would provide almost complete coverage of the eastern two-thirds of the state. Specific objectives to be accomp-lished during the remainder of fiscal year 1997 are:

1. Assist Starlink in obtaining a temporary FCC license to transmit at Coast Guard frequency from the Temple site,
2. Complete the retrofit of the Temple tower and antennae,
3. Prepare physical space at Temple site to house electronic components,
4. Install the GPS receiver and the radio transmission equipment,
5. Work with the National Telecommunications Information Administration to test frequency for conflicts with existing area radio broadcasts, and
6. Field test all equipment.

6.5.2 Increased Coordination with the Federal Government

To ensure that the Texas DGPS network is completely compatible with the National DGPS network, the GPS Coordination Committee will be working with the federal agencies involved in the national network expansion efforts. The goal of this coordination will be for the Beacon Network of Texas to become assimilated into the national network at some point in the future, allowing the state to become users of the system, and not caretakers of the system. Until the federal effort is fully underway, however, the state will be working to both expand and maintain the additional Texas sites. Another goal of our federal/state coordination efforts will be to try and form a partnership in building the additional Texas sites. If we can use a cost-share arrangement to develop additional sites in Texas, this will provide benefits to both state and federal agencies as well as local governments, private interests, and the general public.

The specific objectives that will be pursued are:

1. Create a list of contacts at the federal level and provide them with a needs assessment of Texas users,
2. Continue to work with federal contacts to gain support for additional Texas beacon sites, including possible cost-share or pilot program to ensure site development, and
3. Draft a letter from the GISPC to the Secretary of Transportation outlining Texas' needs and the state's ability to support site development.

6.5.3 Expansion of the BTNT

During fiscal years 1998–1999, the GPS Coordinating Committee will work with its state and federal partners to expand the coverage of the BTNT. Development of 2–3 additional beacon sites during the biennium will bring the total coverage for Texas to approximately 90% (Exhibit 6.6).

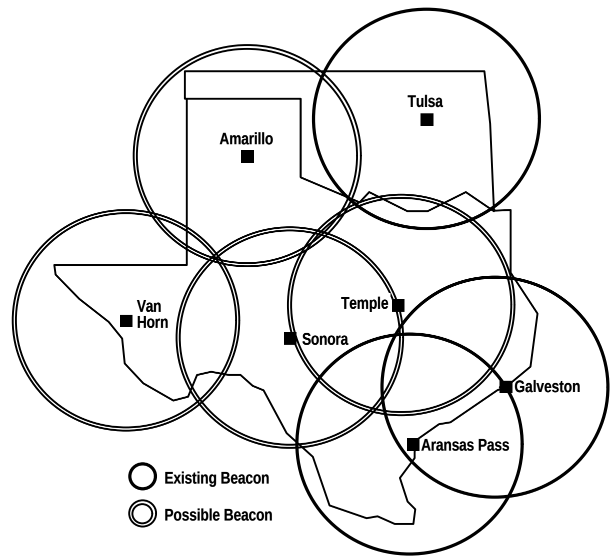
Develop Beacon Site in Texas Panhandle—The development of a site in the Texas Panhandle would provide the first significant coverage for the Western portion of the state. A cooperative, cost-share approach to development of this site will be used, and every effort will be made to include the various federal agencies in expanding the Texas network. Specific objectives identified to date are as follows:

1. Attempt to gain permission from Strategic Air Command to use the Summerfield GWEN site near Amarillo as a pilot site for BTNT,
2. Pursue contacts at Federal Rail Admin-istration and Burlington Northern Railroad to gain support for use of the Summerfield GWEN site as a potential pilot due to the significant rail interests in the area,
3. Include both the state and federal agriculture agencies in development of this site due to the significant farming interests in the area,
4. Develop a proposal for the retrofitting of the GWEN site based on equipment needs and costs,
5. Identify alternative sites (i.e., towers) that might be made available for shared use, and
6. Obtain in-kind contributions and/or funds to develop the Panhandle site.

Develop Beacon Site in West Texas—The Midland/Odessa area, with its significant agricultural and energy development interests would be the next targeted area for inclusion in the BTNT. Specific objectives identified to date are as follows:

1. Try to obtain permission from Strategic Air Command, along with support from the FHWA and FRA, to use the Dyess GWEN site near the Midland/Odessa area as a site for BTNT,
2. Evaluate the potential for use of the TxDOT tower near Sonora as an alternate site,
3. Develop proposal for retrofit of an existing tower site based on equipment needs and costs, and
4. Obtain in-kind contributions and/or funds to develop site.

U.S. Coast Guard Beacons



Develop Beacon Site in Southwest Texas—Development of a beacon site in the Southwest Texas area, possibly near Van Horn, could be needed to complete the coverage of the state to near 100% and ensure the inclusion of the El Paso area. Generally, the range of each beacon transmitter has been between 200–250 miles, but some of the transmitters are able to be used as far as 300–350 miles away. Depending on the strength of the signals, and the reliability of the previously established BTNT sites, the Southwest Texas area will be reevaluated for inclusion in the network prior to the end of the 1998–1999 biennium.

6.5.4 Development of Standards and Guidelines for Agency Use

Further development of common procedures and guidelines will allow agencies to take full advantage of the benefits of GPS data collection. Over the past two years, agency personnel have shared common practices as well as new efficiencies in data collection capabilities. This networking among and between agencies and other interested parties should continue to be encouraged in order to reach the goal of "best practices" for all agencies utilizing GPS. The GPS team will work with other GPS users and recognized experts to recommend proper curriculum for new GPS users, and standard procedures for field data collection. This information could be included in the GIS Planning Council's *GIS Getting Started Manual*, which is under development.

The other area where standard procedures and guidelines would be useful for agencies is in the documentation of collected data points. The state would benefit from the development of a standard set of metadata for agencies who are using and providing GPS data to their constituency. Metadata guidelines, including documentation regarding conditions at the time of data collection and data accuracy criteria, would be useful for agencies' internal use as well as for GPS point data that is required by agencies as part of the permitting process for regulated facilities. Classification of GPS point data quality in this manner would be very helpful in building GIS data bases.

6.6 Benefits of Global Positioning System Coordination

6.6.1 Real-Time Broadcast of GPS Correction Data for State Agency Use

The state would benefit by supporting development of the BTNT as a public-use, real-time broadcast network to be used by all state agencies and the public in correcting GPS data. The use of a real-time broadcast network will allow agency staff and other users to capture locational data with accuracies of less than fifteen feet while still in the field virtually anywhere in the state. A statewide network to broadcast GPS corrections would eliminate selective availability and atmospheric distortions from GPS signals. This will eliminate the post-processing requirement. Coordinate-location data captured in this manner would be "GIS ready," and could be used immediately to update GIS data bases. Time required in the field would be greatly reduced since the real-time system can produce accurate location information within one to two minutes, instead of fifteen minutes to one hour. Having location information this quickly means that GPS receivers will also be usable as field navigation tools. The benefits of a real-time broadcast network can be summarized as follows:

- Accurate locations of natural resources and related facilities would be easily determined and loaded into agencies' GIS databases,
- The cost per user for utilizing GPS as a data collection tool would be significantly reduced,
- The state would utilize pieces of the existing statewide infrastructure as well as state-owned lands to develop the network, and
- The Federal government would lend support to the project.

Establishment of a real-time broadcast network to provide differential correction of GPS positioning data in the field rather than using post-processing procedures would provide significant cost savings to the state. Currently, after collecting data in the field, state agencies bring it back to the office to perform differential correction. This process, known as post-processing, is most often performed using RRP control files made available by TxDOT. The post-processing of large amounts of data requires significant computer and personnel resources. Real-time broadcast of correction information would allow field personnel to capture 2–5 meter positional accuracies on-site, and would also allow for easier navigation to known coordinates. The development of a real-time broadcast network by the state would provide a valuable resource to state agencies and could be set up as a public service to other local governments and the general public.

6.6.2 Provide Economic Development Opportunities Based on GPS Technology

Providing a statewide real-time differential correction system based on the U.S. Coast Guard's low frequency beacon system would provide the public with a no-cost DGPS option. Once the beacon receiver equipment is purchased by a user, there would be no ongoing fees to utilize this system. This capability would help stimulate the use of GPS as an advanced technology in the state. Not only would state agency personnel be able to take advantage of GPS statewide, but other public entities and the private sector would also benefit.

As mentioned earlier in this document, there are a variety of uses at the federal level and in the private sector for real-time GPS data collection. These uses include air traffic control, intelligent vehicle highway systems, a new high-tech collision avoidance system for railroads called positive train control, and precision agriculture, a more economical and ecologically sound means of crop production. The development of a DGPS system in Texas that is reliable and cost-effective will provide opportunities for economic development related to these uses and many others. Agencies in all levels of government and private sector companies are constantly coming up with new uses of this technology to create more efficient and effective means of delivery and transportation of goods and services.

6.6.3 Consistent Standards and Guidelines for Agency Use

Federal standards have already been applied in building and maintaining the existing U.S. Coast Guard beacon systems. These standards will make it easier for manufacturers and users of this technology to apply GPS in new and varied ways. Consistent standards and guidelines for state agency use when capturing and cataloging GPS data will make this information more readily accessible to a wider variety of users. It will reduce the need for redundant data collection and will ensure that state agencies and the other governmental entities will be able to share information more effectively.

Partnership Reference Material

The evolving success of statewide mapping and GIS coordination in Texas has developed because of continued coordination among state agencies and between those agencies and the federal, local, and private sectors. This section summarizes that history and describes the nature of the current GIS coordination environment in Texas. The material below is limited to the statewide efforts; many mapping efforts taking place at individual agencies are left out of this discussion.

A.1 Early Statewide Mapping Efforts in Texas

Initial efforts to map the State of Texas started in 1957 with the passage of the Texas Water Planning Act, which directed creation of a statewide water plan. A detailed uniform map coverage was needed for the water plan but only 10 percent of the state was then covered with the required 1:24,000 scale maps. The Texas Board of Water Engineers (precursor of the present Water Development Board) received funds from the 55th Legislature to create the State Cooperative Mapping Program. This program called for establishment of the Texas Mapping Advisory Committee (TMAC), a public/private partnership of government and industry, created in 1960 to oversee map production in Texas.

The Texas Water Development Board and the U.S. Geological Survey (USGS) joined forces in 1958 to fund production of both 1:24,000 and 1:100,000 scale USGS maps. The 1:24,000 scale map, also called 7.5 min Quadrangles or Quads, is a product produced by the USGS National Mapping Division (NMD). At this time, the USGS/NMD had a stated goal of completing a nationwide coverage of these maps. TMAC helped direct the two agencies to provide maps for portions of the state with high-growth potential. From 1958 to 1985, the Water Development Board and the USGS each spent $7,200,000 to complete 7.5 min Quad coverage of the state. Because of this federal/state cooperation, Texas was the first state west of the Mississippi River to be mapped at this scale. Today, TMAC remains active in Texas mapping, although annual funding from the Water Development Board has fallen to $20,000. TMAC is looking at other mapping needs such as aerial photography and digital mapping to update the 7.5 min Quad maps, many of which are now 20–40 years old.

A.2 Texas Natural Resources Information Task Force

In 1968, the Legislature established the Water Oriented Data Bank, whose name was changed in 1972 to the Texas Natural Resources Information System (TNRIS). The mission of TNRIS was to provide a “centralized information system incorporating all Texas natural resource data, socio-economic data related to natural resources, and indexes related to that data that are collected by state agencies or other entities.” (Texas Water Code, Section 16.021.)

Seventeen state agencies and the Governor’s Office have representatives on the TNRIS Task Force, whose member agencies are listed in Exhibit A.1. The Task Force advises TWDB on the most beneficial uses of TNRIS resources and sets TNRIS policy. TNRIS keeps the Task Force apprised of the current number of users and describes any new projects it initiates. The Task Force is a diverse group, with many sources of input, which helps ensure that TNRIS continues to meet the wide variety of Texas agency data needs.

USGS A-16 Program—USGS assisted the state in the early mapping effort through an all federally funded program called the A-16 Program. In more recent years, the A-16 Program gave states the opportunity to influence the priorities for federal mapping with in the states. TMAC, TNRIS, and the TNRIS Task Force helped coordinate the state’s participation in the program. The 1:24,000 maps that TMAC and USGS created between 1960s and 1980 were acquired under an early version of the A-16 Program. Regrettably, the USGS withdrew the opportunity for states to participate in A-16 and are using the process now as an internal (to the federal government) priority setting mechanism. USGS is continuing to support Texas mapping in other ways (see discussion in Chapter 5).

Exhibit A.1 TNRIS Task Force Members

Bureau of Economic Geology, The University of Texas at Austin
Railroad Commission of Texas
Texas Department of Agriculture
Texas Department of Commerce
Texas Department of Transportation
Texas General Land Office
Texas Department of Health
Texas Forest Service
Texas Historical Commission
Texas Natural Resource Conservation Commission
Texas Parks and Wildlife Department
Texas Soil and Water Conservation Board
Texas Water Development Board
Governor's Office (Ex-officio)
Texas Department of Housing and Community Affairs (Ex-officio)
Texas Attorney General's Office
Office of State-Federal Relations

A.3 Early Statewide GIS Coordination Efforts

In the summer of 1990, the Department of Information Resources (DIR) was asked by the Texas Department of Transportation (TxDOT) to coordinate geographic information systems development in Texas state government. In doing so, administrators at the Department of Transportation pointed out the value of GIS technology to state decision makers. TxDOT and DIR agreed that significant cost savings could occur if agencies shared rather than duplicated efforts to implement this valuable, yet expensive technology. After initial research and organization efforts, a core group was identified of those agencies either interested in or already implementing GIS.

On October 25, 1991, DIR chartered the GIS Planning Council (Council). The Council serves as an executive-level body for interagency GIS coordination and consensus-based planning. On April 9, 1992, Governor Ann W. Richards issued Executive Order AWR-92-6, charging the Council with the development of a strategic business plan, standards for resource sharing, and public sector partnerships with federal and local governments to aid in the implementation of this valuable technology (see Exhibit A.2).

Over the ensuing months, 20 agencies and related entities joined the effort to create the statewide GIS Business Plan and data sharing standards and guidelines. The continuing involvement of these agencies in developing statewide consensus-based coordination has proven a valuable source of advice and support.

In 1992, the Council chartered the Spatial Data Standards Committee and the Attributes Standards Committee were created and later merged into one committee called the Texas GIS Standards Committee. This group developed the document, *Standards and Guidelines for Geographic Information Systems in Texas*, published in August of 1992. One of the standards developed was the Texas Statewide Mapping System (Exhibit A.3).

One of the chartered tasks of the Council was to create an official GIS Business Plan that would provide a needs analysis of interagency requirements for GIS layers and assign responsibilities to certain agencies to develop GIS data layers for interagency use. These agencies, known as Base Map Custodians, are those the Council felt should be responsible for creating and maintaining digital base map layers (basic mapping adequate to meet the majority of user needs). These base map layers were logically assigned to a responsible agency. The idea underlying this approach is that digital data layers developed or acquired by state agencies become a strategic asset of the state at-large.

The Council formed a committee to determine the components and characteristics of these base map layers, custodial responsibility, and requirements and methods for development. In September 1992, the committee submit-ted a report, the Base Map Proposal, to the Council. In addition to base map data layers (data layers needed by all or most state agencies), the report also identified the-matic data layers (data layers needed by several agencies). The committee's recommendations were incorporated into the GIS Business Plan, completed in October 1992.

The base map data layers needed by all state agencies and custodial responsibility for each layer are listed below.

Base Map Data Custodians

Base Map Layers	***Responsible Agencies***
Survey Control	Texas Dept of Transportation, General Land Office
Transportation	Texas Dept of Transportation
Political/Administrative Boundaries	Comptroller, General Land Office
Hydrography	Texas Water Development Board, Texas Natural Resource Conservation Commission
Topography	Texas Water Development Board, Texas Natural Resource Conservation Commission

EXECUTIVE ORDER

BY THE

Governor of the State of Texas

THE STATE OF TEXAS EXECUTIVE DEPARTMENT

OFFICE OF THE GOVERNOR, AUSTIN, TEXAS

AWR 92-6

CHARGING THE GEOGRAPHIC INFNORMATION SYSTEMS PLANNING COUNCIL

WHEREAS, the information in the state's custody is a strategic asset belonging to the people of Texas; and

WHEREAS, the information required for executive and legislative decision making provides critical support and is voluminous and costly to gather, automate, and analyze; and

WHEREAS, much of the state's information is geographically referenced and may be presented through geographic information systems (GIS); and

WHEREAS, GIS allows for the exchange of information between levels of government and facilitates the management of the state's natural, human, cultural, and economic resources; and

WHEREAS, there is a need to reduce redundancy in data-collection and development efforts and coordinates the various activities in GIS; and

WHEREAS, the legislature recognized the need for more coordination and cooperation between state agencies regarding information and information resources by creating the Department of Information Resources; and

WHEREAS, the Department of Information Resources has chartered the Geographic Information Systems Planning Council (Council) as an interagency, intergovernmental forum to discuss, debate, and decide issues related to the interagency coordination of geographic information;

NOW THEREFORE, I, Ann W. Richards, Governor of the State of Texas, under the authority vested in me, do hereby charge the Council as follows:

The Council shall plan for the most cost effective means of acquiring and distributing geographic information to the state as a whole and ensure that agency programs are in concert with other state and federal agencies.

Further, the Council is charged to develop a business plan to prioritize and schedule the development of public-funded programs for the acquisition of geographic information of common interest, and to seek partners in the public sector for data development.

Finally, the Council is charged to identify agencies to serve as data custodians and define the roles and responsibilities for the agencies' data stewardship.

Given under my hand this the 9th day of April 1992

Exhibit A.3 Texas Statewide Mapping System Not Available

The table below lists thematic data layers needed by several state agencies and custodial responsibility for each layer. Information for these tables extracted from the GIS Business Plan.

Thematic Data Custodians

Thematic Layers	***Responsible Agencies***
Energy Transmission Features	Texas Water Development Board, Texas Natural Resource Conservation Commission, Railroad Commission of Texas
Water Utility Distribution and Collection	Texas Natural Resource Conservation Commission
Public Utility Distribution and Collection	Public Utility Commission
Land Use and Land Cover	Texas Water Development Board, Texas Natural Resources Information System, Texas Natural Resource Conservation Commission
Surficial Geology	Texas Water Development Board, Bureau of Economic Geology
Floodplains, Water Well Locations, Environmental Features, Meteorology, and Generalized Soils	Texas Water Development Board, Texas Natural Resources Information System
Oil and Gas Wells	Railroad Commission of Texas
Incidents/Point Features	Texas Water Development Board, Texas Natural Resources Information System, Texas Natural Resource Conservation Commission
Historical/Archaeological Features	Texas Historical Commission
Recreational Facilities	Texas Parks and Wildlife Department
Biological Distribution	Texas Parks and Wildlife Department, Texas Water Development Board, Texas Natural Resources Information System, General Land Office
Demography	Texas Natural Resources Information System
State-Owned Lands	General Land Office, Texas Parks and Wildlife
Original Texas Land Survey	Railroad Commission of Texas

The Base Map Proposal and the GIS Business Plan differentiated between the scales of the different data layers, classifying them as:

- Series 1: large scale/small area
- Series 2: medium scale (1:24:000)/medium-sized area
- Series 3: small scale (1:100,000)/large area
- Series 4: very small scale/very large area (whole state)

In September 1993, the Council created the GIS Managers Committee to provide a forum for interagency GIS operations coordination, to supervise future work of the Standards Committee and to develop and revise the statewide GIS Implementation Plan on a biennial basis, to coincide with the state's two year fiscal period.

Major documents produced over several years as part of the GIS coordination effort are listed, along with their publication date and purpose, in the following table. This Implementation Plan supersedes all earlier documents and provides the most current, accurate, and comprehensive explanation of the needs and direction of the GIS coordination effort. These documents are available from DIR. For copies, call 512/475-4700.

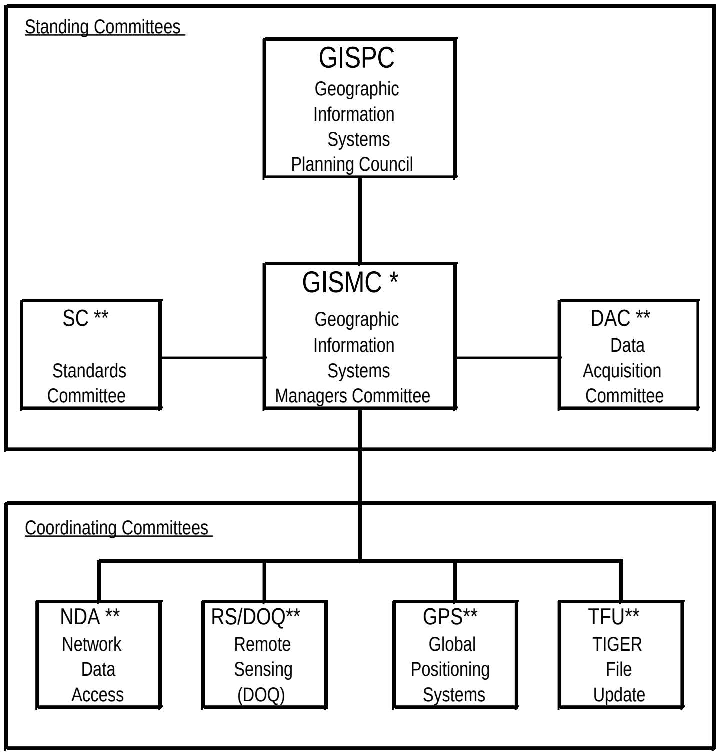
Available Supplementary Documentation

Document Name	***Date***	***Purpose***
Status of GIS at Selected Government Agencies	24-Jan-94	Spreadsheet product of survey developed to determine costs, hardware/ software combinations, projects, and data layers in use at state.
State Strategic Plan for Information Resources Management	Nov-93	Description of goals and objectives for use of information technology at the state.
Plan for Interagency Coordination of GIS	Nov-92	Combined elements of documents in an integrated package to support Council funding requests.
Texas GIS Base Map Requirements Proposal	1-Sep-92	Describes proposed processes for base map data layer acquisition.
Standards and Guidelines for GIS in the State of Texas	Aug-92	Provides quality, accuracy, and data documentation standards for the state (adopted by DIR in Rule).
GIS Business Plan	June-92 (revised Oct-92)	Articulates vision for statewide data sharing and identifies base map data layers.
GIS Implementation Plan: Building Texas GIS Infrastructure	Nov-94	First statewide GIS Implementation Plan
StratMap Concept Proposal	Sept-96	Description of cost-sharing program for statewide digital base map development—supplement to GSC GIS Pricing study.

A.4 Texas GIS Planning Council

The organization of the Council is illustrated in Exhibit A.4. This graphic illustrates the two different types of committees: Standing and Coordinating. Standing Committees focus on broad-scale issues: the nature and direction of overall effort, the operational needs related to cooperation, standards issues, and data development and acquisition issues. Coordinating Committees focus on specific issues or implementation of specific technologies: network data access, remote sensing and digital orthophotography, global positioning systems, and TIGER file update.

Exhibit A.5 (Standing Committee Roles and Responsibilities) and Exhibit A.6 (Coordinating Committee Roles and Responsibilities) describe the missions of each committee, how they relate to other committees, their specific responsibilities, and the name and agency of the current chairs of these committees.



*   Members appointed by Planning Council Representatives
** Chairs for these committees elected from Managers Committee.

Exhibit A.5 Standing Committee Roles and Responsibilities

Name	**Geographic Information System Planning Council**
Mission	Direct interagency GIS planning, policy making, and coordination.
Responsibilities	▪ Establish goals and objectives for mutually supportive GIS environment ▪ Reduce costs through cooperative data development and acquisition ▪ Foster standards-based environment and facilitate cooperative data sharing. ▪ Foster partnerships with federal and local governments using GIS technology. ▪ Oversee the operations of related committees.
Current Chair	Nancy Vaughan, Associate Commissioner for Information Systems, TEA

Name	**Texas/Mexico Border Region Subcommittee**
Mission	Facilitate development of transboundary spatial data for Texas and act as a liaison to Transboundary Resource Inventory Program Committees
Responsibilities	▪ Coordinate, inventory, and maintain information on agency responsibilities, resources, and needs relative to Texas/Mexican border region. ▪ Synthesize needs of Texas agencies relative to geospatial information along the border and propose actions to address those needs.
Current Chair	Tom Thornton, Deputy Land Commissioner, General Land Office

Name	**Geographic Information System Managers Committee**
Mission	Manage interagency operations-level GIS coordination
Responsibilities	▪ Assist the Council in technical and operational issues of statewide GIS coordination. ▪ Develop Statewide GIS Implementation Plan (biannually)
Current Chair	Roddy Seekins, Director, Natural Resources Information, TWDB

Name	**Data Acquisition Committee**
Mission	Manage interagency geospatial data development and acquisition.
Responsibilities	▪ Assess interagency data development and acquisition needs and resources ▪ Prioritize state data development activities ▪ Facilitate cost-sharing for data development ▪ Prioritize state agencies requests for TDCJ services.
Current Chair	Kim Ludeke, GIS Manager, TPWD

Name	**Standards and Technology Transfer Committee**
Mission	Manage Interagency geospatial standards and guidelines development.
Responsibilities	▪ Update Texas standards based on FGDC Clearinghouse standards adoption ▪ Recommend new or updated standards to facilitate Geospatial data sharing ▪ Collect, review, and report on agency geospatial metadata documentation
Current Chair	Drew Decker, GIS Coordinator, DIR

Exhibit A.6 Coordinating Committee Roles and Responsibilities

Name	**Network Data Access**
Mission	Coordinate standards-based geospatial data sharing over the Internet
Responsibilities	▪ Monitor and coordinate technical aspects of Network Data Access initiative. ▪ Facilitate communications between existing and new GIS/Internet users. ▪ Identify and coordinate training opportunities for all state agencies.
Current Chair	Roger Jaster, GIS and Internet Manager, TNRIS/TWDB

Name	**Global Positioning Systems Coordination**
Mission	Promote standardized implementation of GPS technologies at the state and pursue cost-effective means of developing real-time statewide GPS correctional data broadcast.
Responsibilities	▪ Evaluate options and recommend an approach for Real-time broadcast. ▪ Work with agencies to develop standardized methods of GPS use.
Current Chair	Lorelei Weitzel, GIS Applications Manager, RRC

Several of these committees are responsible for development of initiatives in this Plan. The Managers Committee was responsible for overall Plan preparation and development of the Partnership Initiative (Chapter 3). The Network Data Access Coordinating Committee was responsible for the Data Sharing Initiative (Chapter 4). The Data Acquisition Committee was responsible for the Base Mapping Initiative (Chapter 5). The Global Positioning Systems Coordinating Committee was responsible for the Field Data Collection Initiative (Chapter 6). These will also assist in the implementation of their initiatives.

A.5 Agencies Providing Centralized Services

Three entities at the state have missions that involve providing GIS-related services to other agencies: Department of Information Resources (DIR), Texas Natural Resources Information System (TNRIS), and Texas Department of Criminal Justice (TDCJ) Industrial Division. The following table lists these agencies and the services they provide.

Centralized Services

Agency	***Services***
DIR	Interagency coordination support, statewide GIS planning, state representation to national coordination efforts, pilot project development for verifying new technologies
TWDB/TNRIS	Hard copy map and photo clearinghouse and referral center, digital geospatial data clearinghouse and referral center, GIS contract services, TMAC support, and in FY 98–99, StratMap.
TDCJ	Digitization, scanning, key data entry services

Although all agencies participating in the interagency coordination effort recognize their responsibility to work with other agencies, only the agencies listed in this table provide centralized services to all agencies. The following discussion provides further detail on the roles and responsibilities of these agencies.

The Department of Information Resources—DIR provides interagency committee support, statewide planning, system prototyping, consulting, training and liaison with federal agencies and other groups. It is responsible for satisfying the following mandates of the Information Resources Management Act, the enabling legislation for DIR:

- developing the State Strategic Plan for Information Resources Management
- developing the Biennial Performance Report to assess progress made toward goals and objectives of the State Strategic Plan
- monitoring national and international standards, developing and publishing policies, procedures, and standards relating to Information Resource Management by state agencies
- working with the Training and Education section to coordinate an IRM training program
- establishing and operating state technology evaluation and information centers.

To accomplish mandated activities, DIR performs work and provides advisory services in several subject areas, including GIS. DIR employs the GIS Coordinator, who by charter is administration co-chair of the GIS Planning Council. This person provides administrative and staff support to the Council and serves as liaison to federal and local sectors from the Interagency Coordination Effort.

The Texas Natural Resources Information System—The Texas Natural Resources Information System (TNRIS) is administratively a part of and receives funding from the Texas Water Development Board. It is overseen by the TNRIS Task Force. TNRIS has an established Internet presence (Internet node) and has received several grants to assist in developing a better user interface. TNRIS will create this interface with MOSAIC, a public domain Internet client/server program. Users will be able to complete tasks by selecting highlighted icons and text to retrieve data, send messages, and locate information that would otherwise be difficult if not impossible to find.

Texas Department of Criminal Justice (TDCJ)—In July 1993, prompted by the GIS Business Plan, Texas Correctional Industries (TCI) foresaw the need for a data development facility to support agencies using GIS technologies and established a GIS Facility at the Ferguson Unit in Midway, Texas. TCI recognizes its potential role as a data developer in support of the Texas statewide GIS coordination programs, the federal geographic data programs, and Regional Councils of Government data development programs. TCI was encouraged by the Council to be an active participant, due to the labor intensive nature of data development.

The TCI program will benefit state, city, county, and other local governments by accelerating the process of developing digital data at a fraction of the cost provided by private enterprise. This program will help the state financially (by underwriting some of the cost of inmate housing), and will enable inmate workers to have computer skills and training in a rapidly advancing technical field. This will assist them in their re-entrance into the job market.

Nineteen inmates work 2 shifts per day, 5 days per week. The facility is equipped with 15 GIS work stations and 20 data entry stations. This program will make GIS available to communities that have not been able to afford GIS. With state of the art equipment and highly trained personnel, TCI will be able to provide excellent service at greatly reduced rates. Capabilities include scanning, vectorizing, digitizing, and map conversion into GIS format, along with basic CAD operations.

A.6 President's Executive Order

THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release April 11, 1994

EXECUTIVE ORDER

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COORDINATING GEOGRAPHIC DATA ACQUISITION AND ACCESS: THE NATIONAL SPATIAL DATA INFRASTRUCTURE

Geographic information is critical to promote economic development, improve our stewardship of natural resources, and protect the environment. Modern technology now permits improved acquisition, distribution, and utilization of geographic (or geospatial) data and mapping. The National Performance Review has recommended that the executive branch develop, in cooperation with State, local, and tribal governments, and the private sector, a coordinated National Spatial Data Infrastructure to support public and private sector applications of geospatial data in such areas as transportation, community development, agriculture, emergency response, environmental management, and information technology.

NOW, THEREFORE, by the authority vested in me as President by the Constitution and the laws of the United States of America; and to implement the recommendations of the National Performance Review; to advance the goals of the National Information Infrastructure; and to avoid wasteful duplication of effort and promote effective and economical management of resources by federal, State, local, and tribal governments, it is ordered as follows:

Section 1. Definitions. (a) "National Spatial Data Infrastructure" ("NSDI") means the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data.

(b) "Geospatial data" means information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth. This information may be derived from, among other things, remote sensing, mapping, and surveying technologies. Statistical data may be included in this definition at the discretion of the collecting agency.

(c) The "National Geospatial Data Clearinghouse" means a distributed network of geospatial data producers, managers, and users linked electronically.

Sec. 2. Executive Branch Leadership for Development of the Coordinated National Spatial Data Infrastructure. (a) The Federal Geographic Data Committee ("FGDC"), established by the Office of Management and Budget ("OMB") Circular No. A-16 ("Coordination of Surveying, Mapping, and Related Spatial Data Activities") and chaired by the Secretary of the Department of the Interior ("Secretary") or the Secretary's designee, shall coordinate the federal government's development of the NSDI.

(b) Each member agency shall ensure that its representative on the FGDC holds a policy-level position.

(c) Executive branch departments and agencies ("agencies") that have an interest in the development of the NSDI are encouraged to join the FGDC.

(d) This Executive order is intended to strengthen and enhance the general policies described in OMB Circular No. A-16. Each agency shall meet its respective responsibilities under OMB Circular No. A-16.

(e) The FGDC shall seek to involve State, local, and tribal governments in the development and implementation of the initiatives contained in this order. The FGDC shall utilize the expertise of academia, the private sector, professional societies, and others as necessary to aid in the development and implementation of the objectives of this order.

Sec. 3. Development of a National Geospatial Data Clearinghouse. (a) Establishing a National Geospatial Data Clearinghouse. The Secretary, through the FGDC, and in consultation with, as appropriate, State, local, and tribal governments and other affected parties, shall take steps within 6 months of the date of this order, to establish an electronic National Geospatial Data Clearinghouse ("Clearinghouse") for the NSDI. The Clearinghouse shall be compatible with the National Information Infrastructure to enable integration with that effort.

(b) Standardized Documentation of Data. Beginning 9 months from the date of this order, each agency shall document all new geospatial data it collects or produces, either directly or indirectly, using the standard under development by the FGDC, and make that standardized documentation electronically accessible to the Clearinghouse network. Within 1 year of the date of this order, agencies shall adopt a schedule, developed in consultation with the FGDC, for documenting, to the extent practicable, geospatial data previously collected or produced, either directly or indirectly, and making that data documentation electronically accessible to the Clearinghouse network.

(c) Public Access to Geospatial Data. Within 1 year of the date of this order, each agency shall adopt a plan, in consultation with the FGDC, establishing procedures to make geospatial data available to the public, to the extent permitted by law, current policies, and relevant OMB circulars, including OMB Circular No. A-130 ("Management of Federal Information Resources") and any implementing bulletins.

(d) Agency Utilization of the Clearinghouse. Within 1 year of the date of this order, each agency shall adopt internal procedures to ensure that the agency accesses the Clearinghouse before it expends federal funds to collect or produce new geospatial data, to determine whether the information has already been collected by others, or whether cooperative efforts to obtain the data are possible.

(e) Funding. The Department of the Interior shall provide funding for the Clearinghouse to cover the initial prototype testing, standards development, and monitoring of the performance of the Clearinghouse. Agencies shall continue to fund their respective programs that collect and produce geospatial data; such data is then to be made part of the Clearinghouse for wider accessibility.

Sec. 4. Data Standards Activities. (a) General FGDC Responsibility. The FGDC shall develop standards for implementing the NSDI, in consultation and cooperation with State, local, and tribal governments, the private and academic sectors, and, to the extent feasible, the international community, consistent with OMB Circular No. A-119 (“Federal Participation in the Development and Use of Voluntary Standards”), and other applicable law and policies.

(b) Standards for Which Agencies Have Specific Responsibilities. Agencies assigned responsibilities for data categories by OMB Circular No. A-16 shall develop, through the FGDC, standards for those data categories, so as to ensure that the data produced by all agencies are compatible.

(c) Other Standards. The FGDC may from time to time identify and develop, through its member agencies, and to the extent permitted by law, other standards necessary to achieve the objectives of this order. The FGDC will promote the use of such standards and, as appropriate, such standards shall be submitted to the Department of Commerce for consideration as Federal Information Processing Standards. Those standards shall apply to geospatial data as defined in section 1 of this order.

(d) Agency Adherence to Standards. federal agencies collecting or producing geospatial data, either directly or indirectly (e.g., through grants, partnerships, or contracts with other entities), shall ensure, prior to obligating funds for such activities, that data will be collected in a manner that meets all relevant standards adopted through the FGDC process.

Sec. 5. National Digital Geospatial Data Framework. In consultation with State, local, and tribal governments and within 9 months of the date of this order, the FGDC shall submit a plan and schedule to OMB for completing the initial implementation of a national digital geospatial data framework (“framework”) by January 2000 and for establishing a process of ongoing data maintenance. The framework shall include geospatial data that are significant, in the determination of the FGDC, to a broad variety of users within any geographic area or nationwide. At a minimum, the plan shall address how the initial transportation, hydrology, and boundary elements of the framework might be completed by January 1998 in order to support the decennial census of 2000.

Sec. 6. Partnerships for Data Acquisition. The Secretary, under the auspices of the FGDC, and within 9 months of the date of this order, shall develop, to the extent permitted by law, strategies for maximizing cooperative participatory efforts with State, local, and tribal governments, the private sector, and other nonfederal organizations to share costs and improve efficiencies of acquiring geospatial data consistent with this order.

Sec. 7. Scope. (a) For the purposes of this order, the term “agency” shall have the same meaning as the term “Executive agency” in 5 U.S.C. 105, and shall include the military departments and components of the Department of Defense.

(b) The following activities are exempt from compliance with this order:

(i) national security-related activities of the Department of Defense as determined by the Secretary of Defense;

(ii) national defense-related activities of the Department of Energy as determined by the Secretary of Energy; and

(iii) intelligence activities as determined by the Director of Central Intelligence.

(c) The NSDI may involve the mapping, charting, and geodesy activities of the Department of Defense relating to foreign areas, as determined by the Secretary of Defense.

(d) This order does not impose any requirements on tribal governments.

(e) Nothing in the order shall be construed to contravene the development of Federal Information Processing Standards and Guidelines adopted and promulgated under the provisions of section 111(d) of the Federal Property and Administrative Services Act of 1949, as amended by the Computer Security Act of 1987 (Public Law 100-235); or any other United States law, regulation, or international agreement.

Sec. 8. Judicial Review. This order is intended only to improve the internal management of the executive branch and is not intended to, and does not, create any right to administrative or judicial review, or any other right or benefit or trust responsibility, substantive or procedural, enforceable by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person.

WILLIAM J. CLINTON
THE WHITE HOUSE,
April 11, 1994

A.7 FGDC Guidelines to Encourage Cooperative Participation

Purpose

To establish a policy position and criteria for the Federal Geographic Data Committee (FGDC) to participate in, encourage, acknowledge cooperating groups for the purpose of developing the Nation Spatial Data Infrastructure (NSDI).

Goals

1. To further the implementation of the National Spatial Data Infrastructure on a national basis, and
2. To spur cooperation among all parties to improve delivery systems and communication for geospatial data.

Position

The Federal Geographic Data Committee supports cooperation among all parties with a stake in the development and use of the geospatial data. Cooperating groups[1] formed on the basis of relationships that empower all parties to participate in and contribute to the NSDI in those areas of their strength and expertise are encouraged as a desirable mechanism for effective and cost efficient establishment of a national network of spatial data. In recognition of the broad scope and extent of spatial data, the FGDC acknowledges that in most cases no one group will cover all interests within a geographic area and thus not have exclusive domain for representation. Therefore, any number of cooperating groups may be recognized within a geographic area as long as each fulfills the established goals and criteria. Cooperation between federal, state, local, private, and academic sectors should be based on reciprocal needs and expectations aimed at improving the whole geospatial data delivery system. Each should be on the basis of participants contributing what they can that will add value to data sharing and coordination, and to the national infrastructure. Contributions of value include: funding, data, information infrastructure assets, standards, and human resource capabilities.

Advantages of Being Recognized by the FGDC

To build a network of communication and support that facilitates the implementation of the NSDI, the FGDC will be a source of information, consultation, and expertise to the cooperating groups. The FGDC will give value back to partners by helping them: understand how to use the clearinghouse; apply and use standards; and locate sources of data, training, and expertise. Participation of cooperating groups also will provide them the opportunity of publicly stating their involvement in the NSDI while at the same time allowing them to represent and manage their specific interests.

Criteria

To be acknowledged as part of the national coordinating network for the NSDI, the participants must agree to fulfill the following criteria:

- to follow FGDC-established standards for geospatial data transfer, content, collection, and quality control;
- to participate in the FGDC Geospatial Data Clearinghouse, including the use of metadata standards;
- to coordinate data collection and sharing within the geographic area and data categories of interest to the group;
- to participate in the development of a national Geospatial Data Framework;
- to ensure the greatest amount of participation and involvement possible;
- to provide user input and comment to the FGDC and to represent the collective view of the members; and
- to increase awareness of the NSDI and the FGDC, and to represent the FGDC at meetings when requested.

Procedures for Requesting Recognition

Any group wishing to be recognized by the FGDC as a cooperating group for coordination in support of the NSDI should submit a request in writing to the FGDC Secretariat. The request should (a) provide a statement of purpose for the requesting group, (b) list the members of the group, (c) indicate the categories of data and area of geographic coverage of interest to the group, and (d) explain the position and activities of the group relative to the goals and criteria listed above. The FGDC Secretariat will review the request and present it with the appropriate supporting material at the next scheduled FGDC Coordination Group meeting for decision.

The cooperation will be documented by a "Cooperating Group Agreement" signed by a designated representative of the cooperating group and by the FGDC chair or designated FGDC representative. The submitting group will be informed about the FGDC recognition as soon as possible after the decision. The FGDC Secretariat will be responsible for completing the Cooperating Group Agreement and for maintaining a reference file and listing of each cooperating group.

[1] "Cooperating groups" are collections of two or more organizations or entities (e.g., federal, state, or local government agencies, educational institutions, private firms, private foundations, nonprofit organizations, or federally-acknowledged or state-recognized Native American tribes or groups) that collaborate on geospatial data activities.

Biennial Review and Renewal of Agreement

The FGDC will invite renewal of the agreements biennially. Renewal will be based on a review of progress and activities of the cooperating group during the period of the agreement and the membership of the cooperating group at the time of renewal.

Termination of Agreement

Normally, termination will occur when the purpose of the cooperation has been fulfilled.

The Cooperating Group Agreement may be terminated by either party. The cooperating group may terminate the agreement by notifying the FGDC in writing. The FGDC may terminate a Cooperating Group Agreement if the group does not follow the criteria identified above. The FGDC will notify the cooperating group in writing.

Exclusion

This policy for cooperative participation in support of the NSDI will not include activities by the FGDC or its members that are conducted under contractual arrangements.

Network Data Access Reference Material

B.1 Client/Server Tools and the Internet

Client/Server applications consist of two pieces of software that cooperate: the client, which runs on a computer that requests a service, and the server, which runs on a computer that provides the service. Telecommunications networks are the medium through which clients and servers communicate. If the server is not operational, clients can not access services. A server handles a variety of clients. An application protocol usually allows the client and server to differentiate between data destined for the user, and messages the client and server use to communicate with each other.

Metamaking Tools

There are several metadata production tools that are provided by the FGDC and others. Two examples are:

LCRA Metamaker Management System—The Lower Colorado River Authority (LCRA) has received funding through the NSDI Cooperative Agreement to create a metadata tool to assist in organizing GIS data sets at LCRA. The NSDI Cooperative Agreements are administered by the U.S. Geological Survey (USGS). The Texas Department of Information Resources (DIR) is collaborating with LCRA to help build the tool and possibly to implement it via TNRIS for statewide metadata organization.

MetaMaker—To meet the FGDC requirements the Environmental Management Technical Center (EMTC), in cooperation with the Midcontinent Ecological Science Center (MESC), developed MetaMaker, a metadata data entry program. Several available metadata programs were evaluated; none was found to fully meet the FGDC standards and other requirements, such as ease of use and portability, that are basic elements for an agency-wide system.

MetaMaker uses Microsoft Access™ a microcomputer database management system. The program provides the user with data entry forms that represent the sections and elements of the FGDC standards and provides capabilities for printing reports. The compiled version will run on a microcomputer and will be available at no cost.

Several tools, which enhance communications between the client and the server, are listed in Exhibit B.1. These tools can be used to share GIS files over networks.

Exhibit B.1 Internet Client/Server Tools

Z39.50 Client — The Z39.50 Client uses Z39.50 information retrieval protocol to enable users to retrieve bibliographic data from multiple Z39.50-compliant servers regardless of the server software. This allows the search and retrieval of information from multiple remote systems simultaneously

Z39.50 Http Gateway — The combination of a http server, a zgate and a zcon represents the gateway running on a single machine. A WWW browser connects to the http server and posts an HTML form containing information related to a new or existing Z39.50 session. The zgate CGI application parses that form and either starts a new zcon process or connects to an existing zcon process. The user's request is then passed from zgate to the appropriate zcon which in turn communicates with the remote Z39.50 server. The results are passed back from the Z39.50 server to zcon, back to zgate, back to the http server and back to the WWW browser for display to the user. The zgate CGI process then exits, but the associated zcon process stays alive, holding open the Z39.50 connection. If a zcon process receives no input for a pre-configured period of time, the process exits.

Isearch — Field-based searching via "document types." A document type is a self-contained C++ class that defines how to index a certain class of fielded documents.

WAIS — Wide Area Information Servers. This service searches indexed materials for particular words or phrases. A list of on-line files that contain those words is provided.

WWW — WorldWide Web. This hypertext-based service accesses different resources, and allows cross-references (or links) between related resources.

The Internet is a giant "network of networks" that links millions of computers around the world and offers a wide range of services, including electronic mail, bulletin boards, file transfer, remote login and index programs. Internet originated 20 years ago as a U.S. Defense Department experimental network (ARPAnet) designed to support military research on how to build networks that could withstand partial outages and continue to operate. To send a message or information on ARPAnet, a computer only had to put data in a format, called an Internet Protocol (IP) packet, and "address" the packet. The communicating computers, rather than the network, ensured that the communication was accomplished. This approach allowed, for the first time, a computer on the network to talk with any other computer on the network. This was a great improvement over the previous dedicated-line approach to tele-computing

Internet developers, responding to market pressures, began to put IP software on every type of computer, making it possible for computers from different manufacturers to communicate. In addition to reducing vendor dependency, this attractive feature allowed vendors to purchase computers which not only satisfied their specific needs but would also communicate with other network computers.

Network data transport is primarily governed by the transport protocol, file size versus bandwidth, and the distances between locations that data is traveling to and from. When data transport involves dissimilar computer operating systems, Internet Protocol (IP) is clearly the protocol of choice. Bandwidth affects data transport performance and cost. The larger the bandwidth, the higher the data transport rate and the greater the cost for the telecommunications carrier(s). Other technical issues important to network data transfer include data request authentication, traffic analysis, and data compression algorithms. As GIS data-sharing continues to evolve, these issues become increasingly important.

High-speed Internet connectivity can provide the communications backbone to allow agencies to share GIS data in a timely manner. In addition to rapid, convenient, user-friendly exchange of data, Internet supports electronic mail (e-mail), access to libraries, and data searches. Many state agencies currently have access to Internet through fiber optic lines. The existing fiber optic network of the Capitol Complex, which can transfer data at one hundred megabits-per-second (mbps), provides a tremendous resource to attached agencies. Soon this 100 mbps capability will be extended to outlying facilities, uniting more state agencies on a network powerful enough to efficiently share geographic data files.

The discussion below describes network connectivity among state agencies based on their locations: first, for the capitol complex and greater Austin area; second, for major metropolitan areas; and third, for remote sites.

State Capitol Complex and Greater Austin Area Connectivity

The Capitol Complex Network (CapNet), managed by the General Services Commission (GSC), and the Greater Austin Area Telecommunications Network (GAATN), currently under construction (see Exhibit B.2), are the two major networks for data transport in Austin. Both use fiber-optic rings as telecommunication medium, operate at a 100 mega bit per second (mbps) data rate, and have sufficient bandwidth to allow connected agencies to share GIS data.

Exhibit B.2 Description of GAATN

The Texas General Services Commission (GSC), the University of Texas Systems, the City of Austin, the Austin Independent School District (AISD), Travis County, and Austin Community College (ACC) have jointly constructed and use the Greater Austin Area Telecommunications Network (GAATN). The purpose of the partnership is to provide a cost-effective fiber optic communications network that will provide all participating entities with rapid data exchange capability.

This partnership is structured so that each entity owns a portion of the network and shares operational and maintenance expenses based on that entity's percent of occupancy and ownership. The network will consist of multiple strands of fiber optic cable arranged in eight rings and two super rings that will be accessible from almost any location in the city. It is designed both to facilitate expansion to additional locations and to remain operative despite disasters, such as cable cuts.

Installation of GAATN has begun. It will take approximately two years for completion. Portions of the network, when completed, will be accessible for use during the construction period. The GAATN will be one of the most sophisticated private networks in existence and will fulfill the shared vision partnership between all of the co-participants well into the twenty-first century.

As a result of GAATN, the broad bandwidth communications capability currently available to state agencies within the Capital complex will soon be extended to agencies residing anywhere in the greater Austin area. This means the physical infrastructure required for GIS data sharing between the headquarters of most state agencies is either currently available or will be available within two years. The legislature and other state leadership will likewise be able to use these telecommunications capabilities to access key agency information.

The variety of institutions involved in GAATN presents an opportunity to use the data-sharing technologies presented in this plan among key entities in the Austin area. This will enable governmental, educational and private sector entities at different levels to work together. The Austin area has the potential to become a prototype for federal/state/regional data-sharing partnership.

Each of the participating entities will own its own strands of fiber optic cable on the network, essentially creating seven individual networks riding along the same network path. The largest part of the network will be aerial, with underground cabling only where necessary. The number of strands of fiber optic cable will vary depending on the presence of an entity along a particular route, coupled with the bandwidth requirements for each entity. This same formula is the basis for determining percentage of ownership rights among the participating members. The Austin Independent School District is the majority owner, with approximately 35% of the network ownership rights. The District owns 36 strands of fiber optic cable throughout the entire path of the network. AISD also serves as the Construction Manager for the construction portion of the project, and currently serves as fiscal agent for the GAATN consortium.

Included in this project for AISD is the installation of a large Northern Telecom telephone switch, which will be used to provide digital telephone service to all AISD sites. AISD has acquired the 414 telephone exchange, which will be unique to AISD, and is currently in the process of converting each site from an independent telephone system onto the district-wide 414 exchange as the fiber optic connection is completed. All AISD sites should be on the 414 telephone exchange by the end of the first quarter of 1996.

Currently, routers are being installed at each of the ten AISD high schools and the Professional Development Academy to begin testing data transmission over the wide area network. Connectivity to remaining AISD schools will require additional equipment and wiring within these schools to provide the infrastructure necessary to fully connect to and use the wide area network. These additional infrastructure requirements have been identified and will be part of the AISD bond proposal in early 1996.

Major Metropolitan Area Connectivity

The Texas State Network, available in major metropolitan cities, including Houston, Dallas/Fort Worth, San Antonio, etc., provides Internet access to agencies located in metropolitan areas. This network is also tied in to the CapNet fiber network and will soon be connected to GAATN. Satellite cities may need to order dedicated data lines from telecommunications carriers to connect to these major cities to gain Internet access.

The largest and best equipped regional Council of Governments (COGs) are located in major metropolitan areas. These COGs are excellent locations to have servers on the network. These servers could make data generated at the COG or other regional/local entities available for downloading. The servers could also establish links into state and federal databases.

Remote Site Connectivity

Remote and isolated sites can use an asynchronous dial-up service, such as UNIX-to-UNIX-Copy (UUCP), to transfer small amounts of GIS data. These sites could benefit from ordering large amounts of GIS data on tape or other suitable media.

Security for Computers Connected to Wide Area Networks—In response to the recommendations of the State Strategic Plan for Information Resources Management, state agencies are connecting to existing wide area networks or developing their own. Such actions increase the vulnerability of computer systems to unauthorized use and misuse. This section alerts state agencies to the possibility of such unauthorized use and identifies security resources for agency Information Resources Managers (IRMs).

A current rule requires all statewide area networks to eventually be TCP/IP compliant. Most existing statewide area networks already meet this requirement. Because of this, only TCP/IP networks will be addressed. In many cases the issues discussed will be applicable to other wide area network protocols.

It is impossible to compile a complete list of all the risks confronting a computer connected to a public, wide area network. Some generic risks, including examples, are provided in the following table. The resources listed later in this section identify more specific information risks and ways to handle them.

Types of Internet Security Risks

Type of Risk	*Description*
Read Access	An intruder may gain access to a system and read or copy information that is sensitive or restricted.
Write Access	An intruder may write to, modify or destroy data on a computer, including planting “Trojan horses,” viruses, and “back doors.”
Denial of Service	An intruder will deny normal use of a system or cause failure and system shutdown by consuming all of the CPU, memory or I/O bandwidth, including network bandwidth.

Examples—Password Cracking, Breaking and Theft: In many cases password files on Unix-based computers are not read-protected. Even though the passwords are encrypted with a non-reversible encryption scheme, it is possible to apply brute force and a little intelligence to the file and successfully find passwords for accounts. There are several programs that are distributed widely on the Internet that will do this for anyone taking the time to try. This attack method is successful usually because of poor password form. Applying simple rules to the formation of passwords will slow if not stop this process.

Exploitation of Application Software: The widely publicized Internet Worm of November 1988 is an excellent example of this vulnerability. This attack on multiple computers took advantage of several problems in application programs. One part of this attack used the Internet mail system and another used weak security in a remote login procedure. These vulnerabilities were either unknown or ignored before the Internet Worm struck. Since that time vendors and computer systems administrators have been much more active in identifying and correcting these weaknesses.

Solutions—There are several software packages available for Unix-based systems that will check system weaknesses and suggest corrective measures. Systems administrators should make appropriate use of these packages. It is also necessary for systems administration to make use of the communications methods made available by the network to keep abreast of the latest information.

In 1985, a computer crimes law for the State of Texas took effect. Under this law, it is a crime to make unauth-orized use of protected computer systems or data files on computers, or to make intentionally harmful use of such computers or data files. The seriousness of such a crime ranges from Class B misdemeanor to third-degree felony (Section 1. Title 7, Chapter 33, Texas Penal Code).

Copies of the following documents are available for inspection at the DIR Technology Information Center.

- *Information Resources Security and Risk Management Policy Standards and Guidelines,* Department of Information Resources, State of Texas, March 1993, 95 pages.
- *Coping with the Threat of Computer Security Incidents: A Primer from Prevention through Recovery,* Russell L. Brand, June 8, 1990, 58 pages.
- *An Architectural Overview of UNIX Network Security,* Robert B. Reinhardt, DRAFT, July, 1994, 5th edition, 20 pages.

The following is a non-exhaustive list of people or organizations that should be contacted in the event of a security incident at a state agency:

- CapNet
- Department of Public Safety
- General Services Commission, Statewide Telecommunications
- Computer Emergency Response Team (CERT)

In 1988, the Defense Advanced Research Projects Agency (DARPA) established the Computer Emergency Response Team (CERT) to assess computer security concerns of the Internet research community. Currently, CERT consists of hundreds of highly qualified volunteers throughout the computer community as well as permanent staff compensated through federal grants. CERT, which should be notified via e-mail of every security incident perpetrated from a source outside Texas state government, may be contacted as follows:

Emergencies: +1 412 268-7090
FAX: +1 412 268-6989
E-mail: cert@cert.org

U.S. Mail:
CERT Coordination Center
Software Engineering Institute
Carnegie Mellon University
4500 Fifth Avenue
Pittsburgh, PA 15213-3890

Systems administrators should consider subscribing to two CERT e-mail mailing lists: (1) for CERT advisories on newly detected problems, cert-advisory-request@cert.org, and (2) for information on security tools, cert-tools-request@cert.org. The USENET newsgroups comp.security.announce echoes the announcements sent to the cert-advisory list. In addition there is extensive security information available via anonymous ftp from cert.org.

Systems administrators with access to USENET newsgroups should consider reading comp.security.misc, alt.security, comp.risks and comp.virus. For ongoing information on network firewalls, subscribe to the firewalls e-mail mailing list by sending e-mail to majordomo@greatcircle.com with a message line that says “subscribe firewalls.”

B.2 National Spatial Data Infrastructure-Related Homepages

This section provides Internet addresses to homepages that house geospatial information and related information. Some of these comply with National Spatial Data Infrastructure (NSDI) standards**.** Some of these provide information on metadata standards and examples. Appendix B.3 provides Internet addresses of discussion groups and other forums that focus on NSDI related topics. These sections are included to provide readers with examples of Internet data sharing activities now existent, and with a means to pursue their own interests via Internet mail and World Wide Web browsers. These are not exhaustive lists, but should provide sufficient options to pursue a wide variety of reader interests. These resources further demonstrate the concerted efforts to use the Internet to share information and ultimately reduce duplication of effort.

The homepages in the following table are grouped according to their subject matter and point of origin. Texas homepages are listed first, followed by federal, national, and other state’s homepages. International sites are listed last.

Organization	URL
Texas Homepages	
North Central Texas Council of Governments	http://www.nctcog.dst.tx.us
Sam Houston State University: TRIES GIS Lab Manager	http://www.shsu.edu/~triesgis
TAMU Mapping Sciences Laboratory	http://mslismpa.tamu.edu/msl.html
Texas Department of Information Resources	http://www.dir.state.tx.us
Texas General Land Office	http://www.glo.state.tx.us
Texas Natural Resources Information System (State NSDI Clearinghouse)	http://www.tnris.state.tx.us
Texas Parks and Wildlife Department	http://www.tpwd.state.tx.us
Texas Railroad Commission	http://www.rrc.state.tx.us
Texas Water Development Board	http://www.twdb.state.tx.us
Texas Wetlands Resource Database	http://www.glo.state.tx.us/wetnet
Texas Natural Resource Conservation Commission	http://www.tnrcc.state.tx.us (TNRCC has developed 377 DRG's to USGS standards for both sides of the Texas/Mexico Border. These include 300 1:24,000 7.5 minute quadrangles and 77 1:50,000 Cartas Topografica. Initial coverage is two maps deep on each side.)
Texas Orthoimagery Program (TOP) homepage	http://www.txdoqq.com
Sabine River Authority	http://www.sra.dst.tx.us
University of Texas at Austin Texas Space Grant Consortium Department of Geography	 http://www.utexas.edu/tsgc/ http://www.utexas.edu/depts/grg/main.html
University of Texas at Dallas, The Bruton Center (The North Texas GIS Consortium)	http://www.bruton.utdallas.edu
Federal, National, and Other State Homepages	
American Library Association (ALA) The largest and oldest library organization: a century's experience with intellectual freedom issues.	http://www.ala.org
Corporation for Public Information	http://ourworld.compuserve.com:80/homepages/corp_for_pub_info/homepage.htm
EROS Data Center	http://edcwww.cr.usgs.gov/eros-home
Environmental Systems Research Institute (ESRI)	http://www.esri.com ESRI has medadata papers at: http://www.esri.com/resources/userconf/proc95/to300/p259.html

Organization	URL
	http://www.esri.com/resources/userconf/proc95/to250/p208.html
Federal Agency Servers Web Policy Guidelines	http://skydive.ncsa.uiuc.edu/consortium/guide/hmpggl.htm
Federal Technology Transfer Opportunities on the Internet	http://www.nalusda.gov/ttic/
Florida Metadata Validation Service This service uses Peter Schweitzer's compiler for formal metadata developed at USGS.	http://www-mel.nrlmry.navy.mil/meta-val.html*
Intergraph Corporation	http://www.intergraph.com
Intergraph's International Mapping/GIS and Civil Eng. Newsletter Intergraph GeoMedia Web Map test drive	http://www.intergraph.com/infrastructure/publications/ global4/ http://www.intergraph.com/iss/geomedia
Maine, University of Maine Library/National Center for Geographic Information and Analysis, Spatial Odyssey, WWW access to the full text of GIS conference proceedings.	http://www.odyssey.maine.edu/gisweb/
Master Environmental Library Technical Lead at NRL, Monterey, CA	http://www-mel.nrlmry.navy.mil/homepage.html
Montana, (WAIS server and FGDC compliant metadata)	http://nris.msl.mt.gov/gis/mtmaps.html
National Aeronautics and Space Administration (NASA)	http://research.ivv.nasa.gov/projects/WISE/wise.html http://titania.gsfc.nasa.gov/advlandsat/ http://www.hq.nasa.gov/office/mtpe/nra.html
National Wetlands Inventory homepage	http://www.nwi.fws.gov
PCI (image processing software corporation)	http://www.pci.on.ca
Tri-Service CADD/GIS Technology	http://mr2.wes.army.mil
U.S. Department of Commerce World Pop Clock 1990–94 Estimates of State Populations by Race and Hispanic Origin 1990–94 Estimates of County Populations by Race and Hispanic Origin	http://www.census.gov/ipc-bin/popclockw http://www.census.gov/population/www/st9094.html http://www.census.gov/population/www/co9094.html
U.S. Department of the Interior FGDC homepage NSDI Clearinghouse	http://www.fgdc.gov http://nsdi.usgs.gov/nsdi/pages/usgsquery.html
Miscellaneous federal sites with WAIS servers that are known to the FGDC (Note: not all of these sites have FGDC-compliant metadata, but they all have metadata in some form.)	http://www.esdim.noaa.gov/NOAA-Catalog/NOAA-Catalog.html http://nsdi.usgs.gov/nsdi/index.html http://www.nwi.fws.gov/ http://www.epa.gov/docs/pubwais.html http://gcmd.gsfc.nasa.gov/ http://corps_geo.usace.army/mil

Organization	URL
BLM Geospatial Homepages Minimum metadata compliancy (only mandatory fields) More compliant version of document.aml (called blmdoc.aml)	http://www.blm.gov/gis/gishome.html http://www.blm.gov/gis/meta/minimum.html ftp://ftp.blm.gov/pub/gis/blm
WWW mapping and/or metadata sites	http://www.blm.gov/gis/nsdi.html
WWW mapping and/or metadata sites	http://www.blm.gov/gis/nsdi.html
GIS utilities and related stuff	ftp://ftp.blm.gov/pub/gis
USGS National Mapping Division	http://nsdi.usgs.gov/nsdi
NBS MetaData entry program: MetaMaker	http://www.nbs.gov/nbii/whatsnew/metadata.html
U.S. Department of Transportation	http://www.dot.gov/affairs/dot6296.htm
U.S. EPA's Web site	http://www.epa.gov
EPA's National Geospatial Data Clearinghouse EPA Region 1 EPA Region 6 National Spatial Data Library System (NSDLS) EPA Reach File homepage	http://nsdi.epa.gov/nsdi/ http://www.epa.gov/region01/ http://www.epa.gov/earth1r6/ http://epawww.epa.gov/NSDLS/www/html/reqmt_rvw.html http://www.epa.gov/OW/rf/rfindex.html
U.S. Fish and Wildlife Service Endangered Species Environmental Contaminants Program Minnesota Valley National Wildlife Refuge National Education and Training Center Press Releases and Speeches Region 2, (Southwest) Region 3 (Great Lakes-Big Rivers Region) Region 6 (Mountain-Prairie Region) San Francisco Bay National Wildlife Refuge	http://www.fws.gov/ http://www.fws.gov/~r9endspp/endspp.html http://www.fws.gov/~r9dec/ecprog.html http://www.fws.gov/~r3pao/mnvhome.html http://www.fws.gov/~bennishk/netc.html http://www.fws.gov/~r9extaff/pubaff.html http://sturgeon.irm1.r2.fws.gov/ http://www.fws.gov/~r3pao/r3home.html http://www.r6.fws.gov/www/fws/ http://www.r1.fws.gov/sfbnwr/sfbnwr.html
Wisconsin NSDI Clearinghouse	http://badger.state.wi.us/agencies/wlib/sco/pages/wisclinc.html
Wisconsin spatial WAIS metadata searcher	http://badger.state.wi.us/agencies/wlib/sco/pages/wiscsrch.html
Metadata Content Viewer	http://badger.state.wi.us/agencies/wlib/sco/metaprim/colrstd.htm
DOQ: interactive browser over Washington DC	http://www.c3.lanl.gov/~cjhamil/Browse/main.html
Envirofacts	http://www.epa.gov/enviro/html/ef_home.html
Metadata Validation Service Recent improvements: ▪ Uses July 3, 1995 version of mp, Peter Schweitzer's metadata compiler (no support for the -c option). ▪ Supports ftp and http protocols for accessing your metadata files.	http://www-mel.nrlmry.navy.mil/mel-bin/meta-val

Organization	URL
▪ Improved error handling.	
Missouri GIS Homepage	http://www.win.org/library/services/gishp.htm
Metadata tools	http://www.blm.gov/gis/nsdi.html
National Performance review and subsequent reports	http://www.npr.gov
International Homepages	
CIESIN's Gateway World Bank datasets: Social Indicators of Development, 1994 Trends in Developing Economies, 1994	http://www.ciesin.org/gateway/gw-home.html http://www.ciesin.org/IC/wbank/sid-home.html http://www.ciesin.org/IC/wbank/tde-home.html
Socioeconomic Data and Applications Center (SEDAC) Demographic Data Viewer Stratospheric Ozone and Human Health	http://sedac.ciesen.org/ http://sedac.ciesin.org/plue/ddviewer http://sedac.ciesin.org/ozone
Digital Chart of the World	http://ilm425.nlh.no/gis/dcw/dcw.html
Environmental Resources Information Network (ERIN)	http://www.erin.gov.au/
Tijuana/San Diego Border Research	http://gort.ucsd.edu/mw/tj/tj.html
Transboundary Resource Inventory Project (TRIP)	http://www.glo.state.tx.us/infosys/gis/trip/

B.3 NSDI-Related List Servers (Internet Discussion Lists)

A list server is a computer program that will accept an e-mail message, archive it in its database, and then mail a copy of it to every subscriber on the mailing list. LISTSERV (also called BITNET LISTSERV) is one of the automated programs. However, there are other programs such as listproc (Unix ListProcessor), majordomo, Mailbase, Mailserv, etc., which are very similar. These programs are often referred to as newsgroups or forums. Newsgroups archive e-mail messages and only provide those messages that are requested.

Mailing lists have two addresses. It is important to understand the difference.

- The ListServ address is the address of the automated program which processes the list. As such, it is an administrative email address to which users send commands, such as SUBSCRIBE, or UNSUBSCRIBE. The ListServ program can only understand the commands that have been built in by the programmer. Users must type commands exactly as instructed using the same spacing, capital letters, words, etc.
- The list address, sometimes called the list-mail address, is the email address to which users send messages that are then distributed to all subscribers to the list. This address frequently is made up of the name of the list, followed by the name of the server. This address is also frequently designated as the Reply-To: address in the e-mail a user may receive from the list.

The good thing about a newsgroup is that if a user does not retrieve their e-mail for any extended period of time they will not encounter an overflowing message box upon their return. The bad thing about newsgroups is that if messages are not retrieved for any extended period of time some messages may be lost or returned. A forum usually is a more moderated newsgroup that saves the messages. A subscription to a listserve will cause all messages posted to the list to be forwarded to all subscribers.

By subscribing to a specific listserve or newsgroup, users can benefit from other people who share common interests and some that can provide ideas and solutions to all subscribers to the service.

Below are some NSDI-related discussion lists and instructions on how to subscribe.

GeoWeb

Archiving, cataloging and retrieval of geographic information
Subscribe to: MAJORDOMO@CENSUS.GOV
To subscribe, e-mail the following line to the Majordomo listserv address:
subscribe MAJORDOMO
Uppercase is not necessary but is used here for clarity. The first line is the only line recognized by the Listserv software. A subject line is not needed. For example:
To: majordomo@census.gov
Subject:
SUB MAJORDOMO Your Name
Post messages to: GEOWEB@CENSUS.GOV
- Homepage: http://wings.buffalo.edu/geoweb

GILS

Implementation issues of the Government Information Locator Service
Subscribe to: LISTPROC@CNI.ORG
To subscribe, e-mail the following line to the listserv address:
SUBscribe GILS your_first_name your_last_name
Post messages to: GILS@CNI.ORG
- Homepage: http://info.er.usgs.gov/gils/

Isite

Discussion of the Isite suite of tools for Z39.50 search and retrieve.
Subscribe to: LISTSERV@VINCA.CNIDR.ORG
To subscribe, e-mail the following line to the listserv address:
SUBscribe ISITE-L your_first_name your_last_name
Post messages to: ISITE-L@VINCA.CNIDR.ORG
- Homepage: http://vinca.cnidr.org/software/Isite/Isite.html

NSDI-L

U.S. National Spatial Data Infrastructure. Issues, policies, and technical questions related to NSDI, metadata, framework, the clearinghouse, and other subjects.
Subscribe to: MAJORDOMO@FGDC.ER.USGS.GOV
To subscribe, e-mail the following line to the Majordomo listserv address:
subscribe NSDI-L
Post messages to: NSDI-L@FGDC.ER.USGS.GOV
- Archives: http://fgdc.er.usgs.gov/nsdil.html

WWW-TALK

- Searchable archives: http://gummo.stanford.edu/html/hypermail/archives.html

WWW-HTML

- Searchable archives: http://gummo.stanford.edu/html/hypermail/archives.html

Base Mapping Reference Materials

Benefits of Data Layers

This section discusses the four main data sets that will be created through StratMap. These are the digital Orthophoto quarter-quads (DOQs), the digital elevation models (DEMs), the digital line graphs (DLGs), and the soils surveys. Each data set is described and the entities that will benefit from its production are discussed. The section on DLGs is divided into six portions; one for each DLG data set, or layer. State agencies are primarily discussed as beneficiaries but some local and federal entities are mentioned too.

Exhibit C.1 Index of Available and Authorized DOQs Not Available

Digital Orthophoto Quarter-Quads

Description—A digital orthophoto quarter-quad (DOQ) is a digital image of an aerial photograph. The area covered is equal to one quarter of a 7.5 minute USGS quadrangle map. Displacements of the image caused by the camera angle and the terrain are greatly reduced by use of DEMs. The DOQ combines the image characteristics of an aerial photograph with the uniform scale and positional accuracies of a map. The 1:12,000 scale DOQs have a one meter pixel resolution and in accordance with USGS standards should have no more than ten meters of absolute horizontal error for 90% of well defined points. In addition, they should have no more than two meters of relative horizontal error. Exhibit C.1 shows the authorized and available DOQs in Texas.

Benefits—Benefits to state agencies are significant. DOQs will be useful for vegetation and habitat analyses (this is especially true for the CIR DOQs). Having an accurate, consistent, and up-to-date base map will benefit data collection and field surveys. The General Land Office (GLO) advocates the use of DOQs for coastal mapping (including the Oil Spill Response Program) and management of state-owned lands. Texas Parks and Wildlife Department (TPWD) can use DOQs for monitoring land use changes and the habitat of wildlife and endangered species. DOQs will help the Texas Natural Resources Conservation Commission (TNRCC) with many tasks, including locations of regulated facilities, monitoring of watercourse changes, identifying non-point pollution sources, and defining watersheds. Land use and land cover information derived from the DOQs will also be used by the Bureau of Economic Geology (BEG) for hydrocarbon and environmental mapping. The Texas Railroad Commission (RRC) would use DOQs for monitoring the state's energy resources. Specific uses include locations of oil and gas drilling sites, current mining operations, and above ground pipelines.

Local and regional governments will be helped by DOQs in infrastructure planning and management. Maps derived from DOQs will be used for park and land management, property appraisal, and watershed and viewshed modeling. Companies such as electric utilities and pipeline companies use DOQs for route planning. Real estate and development companies can use DOQs for assessing properties before land acquisition. DOQs will help avoid environmental mistakes and associated costs to government agencies, individuals, and corporations.

Exhibit C.2 Index of Available and Authorized DEMs Not Available

Digital Elevation Models

Description—Digital elevation models consist of a thirty meter regular grid across a 1:24,000 quad sheet with elevation interpolated for each location. Exhibit C.2 shows the available and authorized DEMs in Texas.

Benefits—DEMs are valuable for developing false 3D surfaces, for delineating watersheds, for depicting viewsheds, and for analyzing the impact of aspect on other phenomena. It is also possible to drape other land features or thematic layers over the DEM generated surface for a unique perspective on these often autocorrelated themes. DEMs when combined using powerful computer workstations can also depict virtual flyovers of the area of interest.

DEMs are a powerful data input for correction of distortion and displacement in DOQs. State agencies use DEMs for landscape modeling, for Bighorn sheep habitat modeling (TPWD), for watershed modeling (TPWD, TNRCC, GLO), for antennae siting (TPWD), for transmission line (LCRA) and pipeline (TWDB) routing, and for viewshed modeling (TPWD).

Digital Line Graph Layers

Description—Digital line graphs (DLGs) are digitized map features from standard USGS quadrangle maps. Each quad map shows a standard set of features including hydrography (water features), transportation (roads and trails), hypsography (contour lines, topography), political boundaries, public land survey system (property divisions), survey control and markers and several other features. DLGs are digitized versions of these map data. Each feature listed above is produced as a separate digitized data layer.

The DLGs have many uses for state, local, and federal entities. Each DLG layer to be produced in StratMap is described below. The benefits realized by state agencies from each layer are listed under each layer.

Exhibit C.3 Index of Available and Authorized Hydrographic (water feature) DLGs Not Available

Hydrography

Description—The hydrography layer contains data related to water features. These include rivers and streams, intermittent streams, lakes, wetlands, reservoirs, and coastlines. Exhibit C.3 shows the hydrography DLGs in Texas.

Benefits—This layer provides valuable information to all groups analyzing water flow, supply, and sources. The Texas Water Development Board (TWDB) must have up-to-date hydrography data for reservoir planning. Accurate data about stream and shoreline locations is crucial to RRC and other agencies for site location and review. TNRCC needs to map stream networks for its mandated functions, such as waste load evaluations, point discharge models, and contamination source investigation. Hydrography is the most important data layer for TPWD applications such as habitat modeling and analyses of a species or biological community. Hydrography is used by GLO, TPWD, and the Bureau of Economic Geology (BEG) for analysis of a variety of environmental factors. TxDOT's Environmental Affairs (ENV) division needs hydrographic data to classify wetlands for mitigation and impacts and the TxDOT Design division needs the data for water flow and drainage.

Exhibit C.4 Index of Available and Authorized Hypsographic (contour) DLGs Not Available

Hypsography

Description—The hypsographic layer describes the land surface (elevations) within a USGS quadrangle (quad) map. The landforms, or topography, are shown. The topography is shown as elevation contours. Each contour is a line representing a constant elevation above sea level. The intervals between contours are measured in feet and vary according to the elevation range within the quad. A coastal quad may have a 5-foot contour interval whereas a quad covering a mountainous area in West Texas may have 20 foot contours. The contours are labeled and spot elevations are included in this layer. Exhibit C.4 shows the hypsography DLGs in Texas.

Benefits—Topography is useful for volumetric calculations in prospecting and in assessment of mineral resources. TxDOT needs the data for water runoff and cut and fill volume calculations. In-house appraisals using GIS topography data can save time and labor in the field. TPWD requires topographic contours for habitat modeling and uses bathymetric data for environmental analyses of coastal areas. Submerged contours and/or digital elevation models are necessary to GLO, RRC and TNRCC for routing oil spill or waste spill response vessels, for dredging activities, and for studies of coastal resources such as reefs and fisheries. TWDB uses topographic data in water planning (well location, sewage treatment sites, reservoir sites)

Exhibit C.5 Index of Available and Authorized Boundary DLGs Not Available

Political Boundaries

Description—Shows administrative boundaries at the local and state levels. These include state, county, city, and national boundaries as well as state lands such as forests and parks. Exhibit C.5 shows the political boundary DLGs in Texas.

Benefits—Political boundaries are crucial for identifying regulatory and jurisdictional limits and are necessary to all agencies that manage lands or resources. For example, TNRCC needs accurate and up-to-date municipal and county boundaries to delineate administrative boundaries for study areas, for permitting water districts and water use areas, and clarifying regulatory authority for regulating water use. State land boundaries are needed by GLO, which is mandated to inventory and evaluate properties owned by other state agencies on a regular basis. GLO also determines entities that might be impacted by oil spills or mineral exploration. Federal lands such as wildlife refuges are attached to regulations restricting mineral drilling and other activities conducted or regulated by state agencies. State and federal parklands contain sensitive areas that must be considered during GLO oil spill response and TNRCC water quality evaluation.

Updated municipal boundaries are necessary for generating population growth projections which are used by TWDB, TNRCC and other agencies. The RRC needs accurate boundaries for regulation of petroleum operations and TxDOT needs boundary information for highway mileage reporting.

Exhibit C.6 Index of Available and Authorized Transportation DLGs Not Available

Transportation

Description—This important DLG layer shows all features associated with most forms of transportation. Examples are roads and highways, dirt roads and trails, railroads, pipelines, docks, and power transmission lines. Several road sizes are generally shown. Larger roads are labeled. Exhibit C.6 shows the transportation DLGs in Texas.

Benefits—Development of the DLG 1:24,000 Transportation Layer for Texas could take full advantage of data development already underway by TXDOT using differentially corrected GPS. TxDOT has a great need for transportation data at a higher accuracy than is currently available. The DLG transportation layer will greatly benefit from input from TXDOT. Existing transportation DLGs can be combined with TXDOT global positioning system data to provide extremely accurate road centerline data. GIS transportation data supports a variety of functions at other agencies. TNRCC requires accurate transportation networks to locate regulated facilities with sufficient accuracy to manage and protect resources and to improve the efficiency of routing inspections. Accurate, accessible transportation data will improve the efficiency of TNRCC's hazardous waste response and GLO oil spill response efforts. Transportation data are also required by TWDB for water planning. Better rail transportation data will aid the RRC in rail safety inspections and accident tracking.

Exhibit C.7 Index of Available and Authorized Public Land Survey DLGs Not Available

Public Land Survey System (PLSS)

Description—The public land survey system (PLSS) is a property mapping system that divides land into parcels based upon the PLSS including township, range, and section information. The PLSS is common in most western states but not used in Texas. The USGS has indicated their willingness to support the creation of a substitute layer for Texas based upon the Original Texas Land Survey (OTLS) recently digitized by the Texas Railroad Commission. Exhibit C.7 shows PLSS DLGs in Texas.

Benefits—Location and analysis of the OTLS relative to other geographic features is needed by TNRCC, GLO, RRC, and other agencies to manage resources, regulate land use, and monitor taxation. RRC has completed digitization of the OTLS, with more than 400,000 land titles, following a major GIS effort. These data can be used to create a national-level data layer supported by USGS for Texas. A digital OTLS layer will allow annotation to be accessed immediately for any survey and will allow surveys to be superimposed over other data layers. Exact benefit assessments are not possible, but direct and indirect benefits of this project would be enormous.

For example, RRC uses the OTLS to locate petroleum wells and to process drilling permit applications. More than one million well sites have been located based on this data layer. A variety of users, including the agency's staff, oil and gas operators, and the general public reference this information. Mapping data is especially important for independent operators for the identification of new drilling areas (independent operators drill nine out of every ten new Texas wells). A single horizontal well that produces an average of 1,000 barrels a day will provide an estimated $1,320,000 in severance tax and sales tax revenue that year (Source: RRC).

GLO uses the OTLS to identify and manage petroleum leases on Permanent School Fund lands and other revenue-generating state lands. GLO could use complete OTLS data to locate forfeited Veterans Land Board tracts and prepare forfeited tract sales books. The State Property Tax Board uses OTLS to provide the Texas Education Agency (TEA) with property value assessments of school districts, to assist local appraisal districts and to render and appeal taxes on Permanent University Fund land. In each of these cases, centralized GIS data will greatly enhance the performance of the agency in its mandated functions.

Indirect Benefits—The U.S. Bureau of Land Management (BLM) has utilized survey data and other base map data created by the RRC to assist in locating and managing federal oil and gas leases on Texas lands. This has enhanced considerably the BLM’s efforts to lease additional acreage in the state and collect revenues from royalties.

Exhibit C.8 Soil Survey Availability Not Available

Survey Control and Markers

Description—Horizontal and vertical survey positions are marked. This control is very important for locating other features with respect to the quad maps. The National Geodetic Survey (NGS) maintains more than 30,000 horizontal (X and Y coordinates) and vertical (X, Y, and Z coordinates) monuments across the state. These monuments are geodetic reference points. They are identified by latitude and longitude and State Plane Coordinates and registered by several federal and state agencies.

Benefits—The DLG survey control network is the basis for the precise location of geographic features in Texas. State agencies need geodetic referencing to ensure that data sets from different agencies or sources will overlay with the proper orientation in the state GIS. TxDOT, for example, needs survey control markers for highway right-of-way surveys. Surveyors throughout the state can use this as reference.

Soil Surveys (SSURGO)

Description—Soil Surveys, also called soil resource inventories, are designed to provide a standard set of soil data and interpretations based on intended use, whether it is for planning, housing, urban development, agriculture, recreation, or forestry.

Soil resources inventories are conducted by trained soil scientists of the USDA Natural Resources Conservation Service. Soil scientists examine soils in the field in order to observe such factors as depth of bedrock, texture (relative percent sand, silt, and clay), structure, acidity or alkalinity, and other physical and chemical properties. The soil scientists then group soils, using aerial photographs (or preferably a DOQ) as a working base. The soil scientists also classify the soil according to an accepted national system of soil taxonomy, which is based on soil interpretations. This classification system ensures that consistent and accurate soil interpretations, for any anticipated use, are made accurately and are based in science. After an area has been inventoried, soil delineations are compiled onto a photographic-base map (again preferably a DOQ). These lines can then be digitized. Exhibit C.8 shows SSURGO soils data in Texas.

Benefits—The 1:24,000 digital soil data can be utilized by cities, counties, state agencies, farmers, ranchers, and land users to generate interpretive maps. The interpretive maps assist in the planning, use, and management of land and water resources. Several specific uses for soil surveys are agriculture suitability, septic infiltration field suitability, and preliminary cost estimates for construction of underground facilities and foundations. Other general uses include planning roads, airports, housing and industry, reducing flooding, controlling sediment, and protecting wildlife.

Appendix D

Global Positioning System Reference Materials

General Description

The Global Positioning System (GPS) is a satellite-based system which allows a person with a GPS receiver to determine a location on the ground, in the air or on water so long as there is a clear path to 4 or more satellites. GPS satellites, put into orbit by the U.S. Department of Defense (DoD), transmit signals which a GPS receiver uses to compute its location. Since placing the first satellite in orbit in February of 1978, the DoD has invested over $10 billion to build a 24-satellite network. Completed in the Fall of 1993, the satellite network now provides 24-hour availability. The Global Positioning System, created by DoD for navigational capabilities for defense systems, is being used effectively by the civilian community.

GPS is virtually a free resource with broad user potential. Hand-held GPS receivers can be used to navigate (determine where you want to go) or establish a location (determine where you are). Some of the practical uses of GPS include vehicle navigation and routing, emergency response, GIS data collection, surveying, wildlife management, natural resource and facility management, and numerous other engineering and mapping applications.

GPS receivers accept the satellite signals and compute latitude, longitude and altitude using complex mathematical calculations. These calculations yield accuracies from 30–100 meters (90 to 350 feet) down to centimeters, depending on the equipment and method utilized. The reason for this wide range of accuracy is the intentional distortion of the satellite signals by DoD. This modification of the signal is done for national security reasons and is known as Selective Availability (S/A). Other reasons for this range of accuracy are atmospheric interference as the satellite signal passes through the earth's atmosphere, and/or the time delay of the signal.

It has become a common practice for civilian users of GPS to remove this S/A distortion and interference by using a second GPS receiver at a known location, referred to as a base station. Data collected at the base stations is used in one of two ways:

1. to remove error in a "post-processing" mode (i.e., use specialized software to merge data from both receivers after collection); or
2. to broadcast correction data in real-time to properly equipped units in the field. Both methods can result in consistent positioning accuracies of 15 feet or better, which meets or exceeds most agency needs.

Typically, the longer the time spent occupying a location, the more accurate the point. Engineering and surveying applications can routinely achieve centimeter level accuracy.

Determining Location

The method of determining the location of the GPS receiver is based upon trilateral calculations from known satellite positions, i.e., the distances from the satellites are used to compute an intersection point, which is the location of the receiver. The receiver needs four satellites to compute a latitude, longitude, and height (elevation). The GPS receiver computes the distance to each satellite by measuring the time delay for each satellite signal. Once the time delay is known, the distance can be easily determined and the location computed.

Types of Receivers

There are various receivers available which give varying degrees of accuracy and offer different features. GPS receiver prices range from a few hundred dollars to many thousands of dollars. Differing features include the number of satellite channels in the receiver, navigation functions, real-time correction compatibility, amount of memory, ability to log attributes, and the sensitivity of the receiver. The different grades of receivers are shown in the following table.

Three Grades of Receivers with Their Capabilities

	Navigation	GIS			Survey	
Method of Correction	None	None	Post-process	Real-time	Post-process	Real-time
Accuracy	100 m	100 m	5 m	5 m	< 1 m	< 1 m
Data Collection	2 min	2 min	10 min	2 min	90 min	15 min

Differential Correction

Accuracies for the three grades of receivers shown above depend on the brand and model of the receiver and also the method used to collect coordinates. The GIS and survey grade receivers will have an accuracy of about 100 meters (because of S/A), unless the coordinates are differentially corrected. It is necessary to use a GPS receiver in combination with a base station (set up at a known location), to cancel the effects of S/A. To get an accuracy of 5 meters (or better than 1 meter with survey grade receivers), it is necessary to differentially correct the position to eliminate S/A effects and errors introduced by the satellite signal passing through the earth's atmosphere. There are two methods of differential correction: post-processing differential correction and real-time differential correction.

Post-Processing Differential Correction

In post-processing differential corrections, locational coordinates are determined after the position information is collected by the GPS receiver, usually at the end of the day or on a subsequent day. In this approach, the user collects satellite information using the GPS receiver and saves the data either to a data logger, a PC, or in the GPS receiver's memory. The positions that the user sees on the GPS receiver during the day have an accuracy of 100 meters because they are not yet corrected. This limits the ability of the user to navigate to a known location.

To remove the error, another GPS receiver must be collecting coordinates at a known location (base station) at the same time that the user is collecting data. After data collection, the coordinates from the base station can be used to correct the positions from the user's GPS receiver. The error is removed by taking information from the base station, collected at the same time as the data in the GPS receiver, and using it to "subtract" out the error to obtain the differential correction. The base station "knows" where it is and can determine the error in the satellite computed position.

This is a simplified description of the correction method. In actuality, errors are determined from each satellite and each of these errors is then removed from the GPS receiver to determine an accurate location.

Differentially corrected results are more accurate than the navigation grade of receiver. However, someone must operate a base station and the correction data must be accessible for later retrieval. This method is useful primarily when going out to collect coordinates. This method is not of assistance when a person is trying to return to a known point, unless accuracy within 100 meters of the known position is acceptable.

Most of the state agencies with accuracy requirements of less than the standard 30–100 meters have been using the Texas Department of Transportation's (TxDOT) base stations in order to obtain the data necessary for differential correction. TxDOT's Regional Reference Points (RRPs) are located strategically throughout the state as shown in Exhibit D.1. The data collected at each of these sites is made available through the agency's Internet web site. Field data collection with GPS within 200–300 miles of a any of these sites can use the data for correction. The TxDOT RRP infrastructure has allowed the agencies to increase the effectiveness of their GPS applications at a very low cost. However, the post-processing required to differentially correct GPS locations can be cumbersome and time-consuming, especially if an agency has numerous GPS receivers deployed in the field.

Real-Time Differential Correction

Real-time differential correction allows accurate coordinates to be calculated in the field instead of after the fact. Using the real-time method, a base station must still be operated, but the corrections from the base station are transmitted to the GPS receiver in the field while the user is collecting coordinates. The transmission can occur by cellular phone, FM radio sideband frequencies, satellite communication, or standard radio signals. In this manner, a GPS receiver equipped with the appropriate hardware not only picks up the GPS satellite signals, but also receives the correction signal from the base station and performs the differential correction in real-time. Locational accuracies using this method can range from 1–5 meters in accuracy, which is suitable for almost all agency GIS applications.

Real-time differential correction is preferred over the post-processing method because there is no longer any additional processing required to capture an accurate coordinate location. Coordinates recorded by the GPS receiver in the field are within the 1–5 meter range at the time of collection. Because of this real-time capability, the GPS receiver can now be used for navigation to a known coordinate location as well as capture an accurate location of a particular site. This is extremely useful if the user is performing field work in an unfamiliar territory, traveling by boat (where fewer landmarks exist), or returning to a previously surveyed location.

Exhibit D.1 TxDOT GPS Regional Reference Point Network Not Available

Glossary

Accuracy—degree of conformity with a standard, or the degree of correctness attained in a measurement. Accuracy relates to the quality of a result; as distinguished from precision, which relates to the quality of the operation by which the result is obtained.

Accuracy requirement—statement of how precise the desired results must be to support a particular application.

Accuracy standards—performance specifications to which a finished product must adhere.

ACSEC—Advisory Commission on State Emergency Communications (State 911)

Area—level of spatial measurement referring to a two-dimensional defined space; for example, a polygon on the earth as projected onto a horizontal plane.

ARPAnet—an experimental network established in the 1970s, where the theories and software on which the Internet is based were tested. No longer in existence.

Attribute—descriptive characteristic or quality of a feature which can be assigned to one or more discrete values in a GIS. Data about geographic features usually stored as text in a database format.

Base data—set of information that provides a baseline orientation for another layer of primary focus, e.g., roads, streams, and other data typically found on USGS topographic and/or planimetric maps.

Base station—a GPS receiver on a known location that may broadcast and/or collect correction information for GPS receivers on unknown locations.

CIR—Color Infra-Red. Infrared refers to non-visible light with wavelengths above 700 nanometers. Most infrared data are collected from reflected infrared light, not emitted infrared energy (heat). Infrared light provides information on vegetative mass and health, as well as information on soil moisture and geology. CIR film shows infrared data typically by coloring the infrared data red, resulting in a false color image.

Client—a software application that works on your behalf to extract some service from a server somewhere on the network. As an example, a telephone can be thought of as a client and the telephone company as a server.

COG—Council of Government

Contour—a line connecting points of equal elevation.

Control point—any station in a horizontal or vertical control network that is identified in a data set or photograph and used for correlating the data shown in that data set or photograph.

Coordinate pair—set of dimensional discrete values describing the location of a point, line, or polygon (area) feature in relation to the common coordinate system of the database.

Coordinate systems—reference frame or system, such as plane rectangular coordinates or spherical coordinates, that uses linear or angular quantities to designate the position of points within that particular reference frame or system. Coordinates are used to represent locations on the earth's surface relative to other locations or fixed references. In planimetric mapping (two dimensional coordinate system) locations are represented by X, Y coordinate pairs while in topographic mapping (three dimensional coordinate system) locations are represented by X, Y, and Z values.

CPA—Comptroller of Public Account

Datum—a mathematical reference framework for geodetic coordinates defined by the latitude and longitude of an initial point, the azimuth of a line from this point, and the parameters of the ellipsoid upon which the initial point is located.

Database—consists of one or more data sets related by a common fact or purpose.

Data capture—series of operations required to encode data in a computer-readable digital form (digitizing, scanning, etc.)

Data element—specific item of information appearing in a set of data, e.g., well site locations.

Data dictionary—description of the information contained in a data base, e.g., format, definition, structure, and usage. It typically describes and defines the data elements of the data base and their interrelationships within the larger context of the data base.

Data quality—refers to the degree of excellence exhibited by the data in relation to the portrayal of the actual phenomena

Data set—collection of similar and related information recorded in a common format.

Data standardization—the process of achieving agreement on data definitions, representation, and structures to which all data layers and elements in an organization must conform.

Data structure—organization of data, particularly the reference linkages among data elements.

DEM—see Digital Elevation Model

DGPS—Differential Global Positioning System

Differential correction—the method (usually done through post processing) of using two GPS receivers, one on a known location and one on an unknown location, using information from the one on the known location to correct the position of the unknown location.

Digital accuracy—refers to the accuracy of digital spatial data capture.

Digital data—of, or relating to data presented in the form of digits—data displayed, recorded, or stored in binary notation.

Digital Elevation Model (DEM)—a file with terrain elevations recorded at the intersections of a fine grid and organized by quadrangle to be the digital equivalent of the elevation data on a topographic base map.

Digital Line Graph (DLG)—USGS product that includes digital information from the USGS map base categories, such as transportation, hydrography, contours, and public land survey boundaries.

Digital Orthophoto Quarter-Quad (DOQ)—a 3.75 minute square distortion free image of the surface of the earth. The imagery has been geographically and photographically rectified to remove all distortion, and meet requirements of the USGS.

Digitizing—refers to the process of manually converting an analog image or map or other graphic overlay into numerical format for use by a computer with the use of a digitizing table or tablet and tracing the input data with a cursor (see also scanning).

DIR—Department of Information Resources

DLG—Digital Line Graph

DNS—Domain Name System

DOD—United States Department of Defense

Domain Name System (DNS)—a distributed database system for translating computer names into numeric Internet addresses and vice-versa. DNS allows you to use the Internet without remembering long lists of numbers.

DOQ—Digital Orthophoto Quarter-quad

DPS—Department of Public Safety of Texas

Edge matching—the comparison and graphic adjustment of features to obtain agreement along the edges of adjoining parts of information.

EOSAT—Earth Observation Satellite Company, operates Landsat remote-sensing satellites and markets data from Landsat and other satellite sources.

Environmental Sensitivity Index (ESI) —An ordinal scale used to indicate the susceptibility, venerability, or sensitivity of an area to environmental degradation. Often used in oils spill response procedures.

Ethernet—a type of local area network. Ethernet determines the way the computers on the network decide whose turn it is to talk. Computers using TCP/IP are frequently connected to the Internet over an Ethernet network.

Feature—objects that have a geographic location that can be represented by one or more points, lines, or polygons.

Federal Information Processing Standards (FIPS)—official source within the federal government for information processing standards. They were developed by the Institute for Computer Sciences and Technology, at the National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards.

Federal Geographic Data Committee (FGDC)—established by the Federal Office of Management and Budget, is responsible for the coordination of development, use, sharing, and dissemination of surveying, mapping, and related spatial data.

FGDC—Federal Geographic Data Committee

FIPS—Federal Information Processing Standard

Format—the arrangement of data in record or file. The way in which data are systematically arranged for transmission

between computers, or between a computer and a device.
Format conversions—converting data in one format into a format usable by another system.
File Transfer Protocol (FTP)—a standard protocol that defines how to transfer files from one computer to another.
FTP—File Transfer Protocol

Gateway—a computer system that transfers data between normally incompatible applications or networks. The term is often used interchangeably with "router," but this usage is incorrect.
Geographic Information System (GIS)—a computer hardware and software system designed to collect, manage, manipulate, analyze and display spatially referenced data. A Geographic Information System (GIS) includes attribute data as well as graphic data which may be in raster or vector form. A GIS may include cartographic and geographic data such as earth science, natural resources, engineering, demographic, cadastral or socio-economic data or any information spatially related. The term GIS includes all types of automated mapping, facilities management, mapping applications from a Computer Assisted Design/Drafting (CADD) system, etc.
Georectify—the process of referencing points on an image to the real world coordinates.
Geospatial—a term used to describe a class of data that has a geographic or spatial nature.
GeoTiff—Recent raster TIFF format which also contains spatial coordinates.
GIS—Geographic Information System
GLO—General Land Office
Global Positioning System (GPS)—a system developed by the U.S. Department of Defense based on 24 satellites orbiting the Earth. Inexpensive GPS receivers can accurately determine ones position on the Earth's surface.
GOV—Governor's Office
GPS—Global Positioning System
GSC—General Services Commission

Imagery—a two-dimensional digital representation of the earth's surface. Examples are a digital aerial photograph, a satellite scene, or an airborne radar scan.
Internet Protocol (IP)—the most important of the protocols on which the Internet is based. It allows a packet to traverse multiple networks on the way to its final destination.
IP—Internet Protocol

Latitude—angular distance measured in degrees, minutes, and seconds, of a point north or south of the equator on the earth's surface.
Layers—refers to the various "overlays" of data each of which normally deals with one thematic topic. These overlays are registered to each other by the common coordinate system of the database.
LC—Legislative Council of Texas
Line—level of spatial measurement referring to a one-dimensional defined object having a length, direction, and connecting at least two points, e.g., roads, railroads, telecommunication lines, streams, etc.
Lineage—information about the characteristics and history of the data's sources.
Longitude—angular distance measured in degrees, minutes and seconds, of a point east or west of the Greenwich Meridian on the earth's surface.
Lt Gov—Lieutenant Governor's Office

Map projection—mathematical model that transforms the locations of features on the earth's surface to locations on a two-dimensional surface.
Metadata—data describing a GIS database or data set including, but not limited to, a description of a data transfer mediums, format, and contents, source lineage data, and any other applicable data processing algorithms or procedures.
MSS—Multi Spectral Scanner, an imaging system used on Landsat remote sensing satellites.

Neutral Data Interchange Format—an intermediate interchange format that allows the transfer of digital spatial data sets from a variety of formats between dissimilar computing systems.
Network File System (NFS)—a set of protocols that allows you to use files on other network machines as if they were local.
Network Information Center (NIC)—any organization that is responsible for supplying information about any network.

Network Operations Center (NOC)—a group which is responsible for the day-to-day maintenance of a network.
NFS—Network File System
NIC—Network Information Center
NOC—Network Operations Center
NSDI—National Spatial Data Infrastructure

OAG—Office of the Attorney General
OCA—Office of Court Administration
Orthophoto—a scanned photograph of the earth's surface that has been processed to remove distortion due to angle away from the photo center (radial distortion) and distortion due to difference in elevation (orthographic distortion).

Packet—a bundle of data. On the Internet, data is broken up into small chunks, called "packets;" each packet traverses the network independently. Packet sizes can vary from 40 to 32000 bytes, depending on network hardware and media, but packets are normally less than 1500 bytes long.
Planimetric mapping—the representation of features within a two-dimensional coordinate system in which locations are represented by x, y coordinate pairs.
Point data—level of spatial definition referring to an object that has no dimension, e.g., well or weather station.
Positional accuracy—term used in evaluating the overall reliability of the positions of cartographic features relative to their true position.
Precision—refers to the quality of the operation by which the result is obtained, as distinguished from accuracy.
Projection transformation—procedure to transfer features from one projection surface to the corresponding position on another projection surface by graphical or analytical methods.
Protocol—a definition for how computers will perform when talking to each other. Protocol definitions range from how bits are placed on a wire to the format of an electronic mail message. Standard protocols allow computers from different manufacturers to communicate; the computers can use completely different software, providing that the programs running on both ends agree on what the data means.
PUC—Public Utility Commission of Texas

Quality and Accuracy Report—documentation on the nature and characteristics of input source materials for each thematic layer in a digital cartographic data set.
Quality Control—process of taking steps to ensure the quality of data or operations is in keeping with standards set for the system.

Raster data—a uniform array or grid of cells defined in row/column sequences with each cell containing a single value. Every location in the data area corresponds to a raster cell.
Real-time differential correction—the method of using two GPS receivers, one on a known location and one on an unknown location, by broadcasting/sending information from the one on the known location to correct the position of the unknown location in real-time.
Rectified—referencing points, lines, and/or features of two dimensional images to real world geographic coordinates, to correct distortion in the image.
Registration—the procedure used to bring two maps or data layers into concurrence via known ground location control points or the procedure of bringing a map or data layers into concurrence with the earth's surface.
Registration tic—geographic control points for a map or data layer within a GIS representing known locations on the earth's surface. They allow all coverage features to be recorded in a common coordinate system (e.g., Universal Transverse Mercator (UTM), or State Plane).
Root Mean Square Error—measure of registration accuracy used during digitizing and coverage transformations. The higher the value, the greater the error.
Router—a system that transfers data between two networks that use the same protocols. The networks may differ in physical characteristics.
RRC—Railroad Commission

S/A—Selective Availability
Selective Availability (S/A)—method for artificially creating a significant clock error in the GPS satellites. The DoD uses

this in the GPS satellite system.

Scale—ratio or fraction between the distance on a map, chart, or photograph and the corresponding distance on the surface of the Earth.

Scanning—an automated means of inputting data. When used in remote sensing applications it refers to the imaging of the earth surface.

SDTS—Spatial Data Transfer Standard

Sec/ST.—Office of the Secretary of State

Server—software that allows a computer to offer a service to another computer. Other computers contact the server program by means of matching client software. Also a computer using server software.

Source material—data of any type required for the production of mapping, charting, and geodesy products including, but not limited to, ground-control aerial and terrestrial photographs, sketches, maps, and charts; topographic, hydrographic, hypsographic, magnetic, geodetic, oceanographic, and meteorological information; intelligence documents; and written reports pertaining to natural and human-made features.

Spatial data—data pertaining to the location of geographical entities together with their spatial dimensions. Spatial data are classified as point, line, area, or surface.

SPOT—A French company (Satellite Pour l'Observation de la Terre) established to develop and market European satellite imagery.

SPOT Scene—Multi spectral imagery of Bands 1, 2, and 3 obtained from European satellite imagery which has a 20 meter resolution and covers an area on the earth's surface of 60 by 60 km (about 37 by 37 miles).

Standards—exact value, a physical entity, or an abstract concept, established and defined by authority, custom, or common consent to serve as a reference, model, or rule in measuring quantities or qualities, establishing practices or procedures, or evaluating results.

S-WAIS—Spatial Wide Area Information Server

SWCB—Texas State Soil and Water Conservation Board

TAHC—Texas Animal Health Commission

TARC—Texas Association of Regional Councils

TCP—Transmission Control Protocol

TDA—Texas Department of Agriculture

TDCJ—Texas Department of Criminal Justice

TDH—Texas Department of Health

TDHS—Texas Department of Human Services

TDOC—Texas Department of Commerce

TEA—Texas Education Agency

THC—Texas Historical Commission

Telnet—a “terminal emulation” protocol that allows you to log in to other computer systems on the Internet.

Terrain Correction—rectifying of imagery to remove distortion caused by changes in elevations on the earth’s surface.

Thematic layer—mapping categories, consisting of a single type of data such as population, water quality, or timber stands, intended to be used with base data.

Thematic Mapper (TM)—Imaging system used on newer Landsat satellites which scans seven (7) bands of electromagnetic radiation. Imagery has greater ground resolution and image quality than MSS.

THHSC—Texas Health and Human Services Commission

TM—Thematic Mapper

TMAC—Texas Mapping Advisory Council

TNRCC—Texas Natural Resource Conservation Commission

TNRIS—Texas Natural Resources Information System

TNRLC—Texas National Research Laboratory Commission

Topographic map—a map which represents the horizontal and vertical positions of features on the face of the earth. Vertical positions are defined by contours or other symbology.

Topology—branch of geometrical mathematics concerned with order, contiguity, and relative position, rather than actual linear dimensions.

TPWD—Texas Parks and Wildlife Department

Transmission Control Protocol (TCP)—One of the protocols on which the Internet is based.
TRC—Texas Rehabilitation Commission
TWDB—Texas Water Development Board
TxDOT—Texas Department of Transportation

UDP—User Datagram Protocol
User Datagram Protocol (UDP)—Another protocol on which the Internet is based.
UNIX—a popular operating system that was very important in the development of the Internet.
Unix-to-Unix Copy (UUCP)—a facility for copying files between UNIX systems, on which mail and USENET news services were built.
UUCP—Unix-to-Unix Copy

Vector—directed line segment, with magnitude commonly represented by the coordinates for the pair of end points. Vector data refer to data in the form of an array with one dimension.

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